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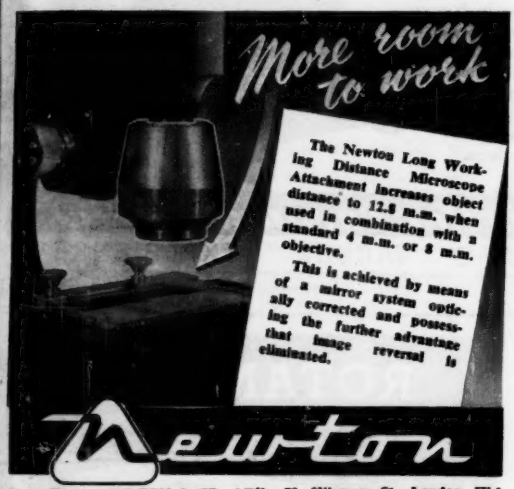
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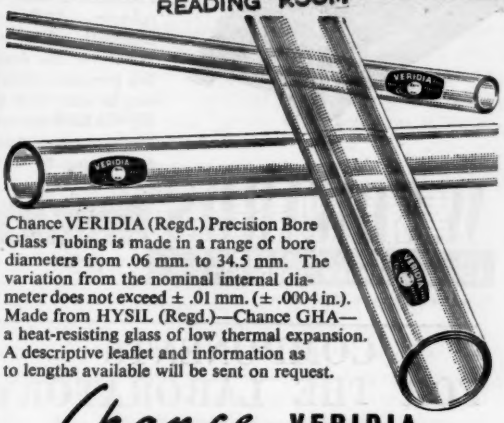

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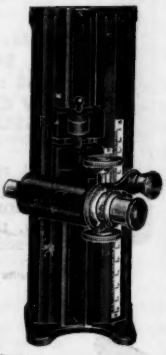

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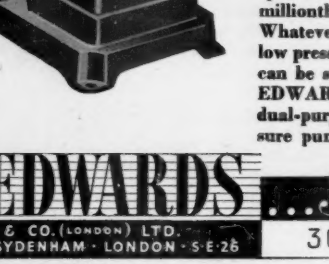

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FUNCTIONS OF THE UNIVERSITIES

IN the picture of the development of Owens College into the University of Manchester of to-day which Prof. Charlton has given us under the title "Portrait of a University", stress is laid upon John Owens's insistence that the College should make full provision to meet the particular needs of its surrounding district and the way in which this has influenced developments. Inherent in such thinking is the conception of the university as a regional centre which Prof. B. Dobrée expounded in his Earl Grey Memorial Lecture in 1943; but it is apparent from the discussion on this subject at the Home Universities Conference last December that the universities are not agreed as to the extent or nature of their regional functions or responsibilities. Prof. Charlton's study scarcely helps us either, for although he demonstrates the great value both to the University itself and to the region of that intimate contact between the university and industry, commerce and other activities of the surrounding area which characterized Owens College from the start, he does not deal with important detail and barely mentions the tutorial classes or extra-mural work.

It is appropriate at the present time that the universities of Great Britain generally should consider carefully not merely whether they are fully discharging their regional responsibilities, but even whether in certain directions they may not be doing too much. Like other institutions, they may be called upon to face greater stringencies in the immediate future, in view both of rising costs and the demands of re-armament. The easing of the immediate post-war pressure now that the Further Education and Training Scheme has terminated should provide them with a valuable opportunity for stock-taking and for closer attention to standards. A decline in the student population of the universities is not *a priori* a matter for complaint at the present time. Even an increased expenditure on the universities may well prove to be best distributed over fewer students, and any breathing space which a decreased entry may afford the universities should be utilized in a careful scrutiny of policy and objectives in all branches of expenditure.

In the first place, it is necessary to be clear as to the functions of a university and the broad objectives of its policy. In one particular field a recent broadsheet (No. 328) issued by Political and Economic Planning makes an important contribution. The universities now spend roughly half a million pounds a year on extra-mural work—that is, on the teaching of those who are not full-time students. This is a sum quite considerable enough to justify P E P raising such questions as whether the standard of extra-mural study is sufficiently high to justify acceptance as of university level, and again whether the universities are here undertaking work which could be done as well by others—a question which it is equally pertinent to ask of some of the technical instruction given at the universities, particularly in view of the current debate on higher technological education.

A brief sketch of the growth and extent of the universities' concern in adult education was given by Mr. W. E. Salt, director of the Department of Adult Education in the University of Bristol, in the *Universities Review* last September (see *Nature*, 167, 1; 1951); but the present broadsheet, although entitled "The Universities and Adult Education", examines the work of the extra-mural departments and its place in relation to the rest of the work of the university, particularly in the light of the views expressed in the last report of the University Grants Committee. While recognizing that much of the criticism of the extra-mural work is valid, the University Grants Committee was then prepared to encourage expansion of such work in the belief that "the universities are making, and should continue increasingly to make, a unique and indispensable contribution to adult education". The broadsheet accepts, for the purposes of its discussion, the possibility of achieving work of university standard in university adult classes and that such work is therefore acceptable as a university function. It seeks, however, to define that function more closely and the way this side of the work of the universities is likely to develop in the future in view of the widening purpose and growing importance of adult education in general.

To some extent this survey by P E P duplicates that made by Mr. Salt. It brings out more clearly the point made by Bruce Truscot, both in "Redbrick University" and in "Redbrick and these Vital Days", that under the conditions of to-day the extra-mural work of the universities, and particularly that of Oxford and Cambridge, might be reconsidered in relation to regional responsibilities and the establishment of further universities during the past half-century. When universities are complaining with reason of administrative responsibilities thrust upon them, any opportunity for eliminating unnecessary administrative complications should be seized.

This point could well be examined more carefully, and in this connexion it should be remembered that it is no longer true that adult education can look only to the university for leadership. If, however, the universities wish to lighten their load here, the decision should be taken in the light of some clear and, if possible, agreed ideas as to the principles which should govern their future policy, both in adult education itself and in their regional activities generally. There are directions in which the universities are being urged to extend their activities, and in spite of the value of the bridge between the university and the community which extra-mural activities provide, as the University Grants Committee remarked in its last report, it is important that the universities should not dissipate the resources available by endeavouring to meet all demands made upon them for the provision of adult education.

Such a policy would not only waste university resources but also almost certainly lead to much overlapping with other organizations. Moreover, just as a university cannot consider its regional functions without having regard to the primary, and universal, responsibility implied in its name, so in accepting responsibilities for the cultural life of those without its walls it must be free from sectional inhibitions: it should be prepared to consider requests from any part of the community. Selection and discrimination are essential, but they must not be arbitrary; they must be in accordance with the university's primary purpose.

P E P suggests as the first criterion for discrimination that the main concern of the university should be with studies of a high academic standard or degree of specialization which only the university can effectively supply. This accords with the general opinion at the Home Universities Conference, where, however, Prof. R. D. Waller also pointed out that such specialist and near-vocational work is likely to increase and to involve extra-mural departments in considerable administrative responsibilities which might distract them from other tasks. Like the University Grants Committee, he recognizes the value of the relationship with the local community established in extra-mural work and is prepared to justify such work in general not only by an obligation to meet the utilitarian demands of local interests but also by the university's own sense of social awareness, including the needs of its staff as well as of its community.

In going so far, Prof. Waller makes the university itself, rather than any principle or set of principles, the arbiter; for defining limits for the work of the universities in education, P E P strongly supports the practice of trusting the discretion of extra-mural departments or directors. So far as the length and organization of classes are concerned or the requirement of some minimum educational standards of adult students, it is urged that any other course is undesirable. In practice, however, the scope of extra-mural work has depended largely on the activities of other bodies, and P E P suggests that by laying on the local authorities the new duty of ensuring that "adequate facilities for further education" are available, the Education Act of 1944 may well mean an increase in the demand for those types of instruction which universities are best fitted to provide, as well as a change in relations with local authorities. The work of the universities, together with that of the voluntary associations, will in future be viewed in relation to the whole structure of further education, and university policy should take this into account.

Whatever the scope of the work eventually undertaken by extra-mural departments, the crucial considerations are the preservation of academic standards and the integration of the department with the main body of the university. Both alike turn on the question of university resources, and failure to fulfil either condition has been the prime cause of most of the criticism of extra-mural work and of the waste of resources. In practice, achievement of the first depends mainly on the extra-mural tutor, and the second partly on internal departmental relations and organization.

The difficulty in regard to the maintenance of standards arises chiefly because it is necessary to employ part-time non-university lecturers. On a

part-time basis such lecturers cannot have the same opportunities of real contact with the university as those who are full-time members of the university's staff. There is, however, now an established body of full-time extra-mural staff, whose employment raises some of the most difficult problems in university adult education. Even these lecturers do not always possess full staff status, which P E P urges is essential if adult education is accepted as a university function.

By itself it is only a first step, and other measures will often be required to enable such lecturers to make a reality of their university membership and to bring them more into contact with other members of the university staff. Mr. Salt fully recognizes this difficulty in his paper in the *Universities Review*, and to what he said P E P adds little more than the suggestion that it would help in the assimilation of the full-time extra-mural staff with the university, and facilitate the transmission to the outside world of the intellectual attitudes and ideals of a university, if the external staff were enabled to do some internal lecturing also and given the opportunity of joining in the research programmes of internal departments. Such measures would demand considerable organization and adjustment, and for the extra-mural department to become more truly part of the university there must first be readiness to co-operate, a strong interest in its work and a sense of responsibility and unity in the university as a whole. Without them adult education or indeed any aspect of extra-mural work is scarcely worth while undertaking.

Nevertheless, however appropriately and adequately staffed may be the extra-mural department which is the main instrument with which the university fulfils its function in this field, there remains the question of resources. Mr. Salt's suggestion that the extra-mural course itself provides the best test is admirable but scarcely sufficient by itself. The course, he suggests, should make such demands that only the serious student is willing to accept its discipline; but in offering such courses a university cannot fail to take account both of the extent of its other responsibilities and resources and of the general conditions in its immediate region and indeed of the country as a whole.

It has already been indicated that university policy in this field requires to take into account the changes in the structure of further education brought about by the Education Act of 1944. It equally involves consideration of the position and growth of secondary education from this point of view no less than from that of entry to the university. Lord Eustace Percy took up this point in his speech at the Home Universities Conference. What appears to be implied above all in the conception of the university as a regional centre in Prof. Dobrée's lecture or in the views expounded by Bruce Truscot is the interchange of thought between the university and its surrounding region, much as, through working so happily with and through the people of the surrounding community, the University of Manchester has largely been shaped in its development by the needs and outlook of the community and, in turn, in expanding, has served these needs. At the basis of that interchange must lie the production of graduates able to think clearly and precisely and to express themselves lucidly, who possess, as Prof. W. Fisher Cassie remarked, the sound and critical judgment, the personality and the readiness to accept responsibility for which industrial leaders look.

Prof. Cassie suggested that it is in the field of applied science that there has been the most marked failure of the universities to satisfy the requirements of their regions for outstanding men capable of assisting their fellows in the application of scientific truths. It is true that, as he observed, constant contact between the staff of a university and the professional institutions and practitioners of the region is the essential basis of regional co-operation; but there may well be other factors which determine the ability of any one university to provide its region with a sufficient number of outstanding men and women. Entry to a university is not determined primarily by the needs of its region, and there is still a tendency for the most promising students to be attracted to a limited number of universities.

The changes in conception and content of the usual technological curriculum suggested by Prof. Cassie, in spite of their undoubted value, will not necessarily, therefore, suffice; but now that it is desirable to reconsider the ways in which the universities distribute their available resources and indeed the functions the universities should perform, it is more important than ever to insist upon the importance of maintaining, if not of raising, standards. So far as technological or science students are concerned, encouraging them in creative work and the assumption of more responsibility may mean a reduction in numbers and an increase in staff and facilities; nevertheless, the nation's needs, even from the point of view of productivity, will be better served by smaller numbers in whose scientific and technological training critical and expressive faculties have been properly developed. Even when that is conceded, it is still true that the universities should be prepared to co-operate in certain regional activities and developments where these promise to enrich the cultural life of the community, in spite of their cost in resources. The Beveridge Committee on broadcasting, for example, directed attention to the opportunity for experiment in Britain with local stations broadcasting programmes controlled by universities.

Such developments are in line with the sketch of the university of the nineteen sixties with which Prof. Dobrée concluded his lecture, and may indeed afford a new and more effective means by which the universities can participate in adult education. Any such new developments must, however, be considered in relation to the university's first purpose—the pursuit and dissemination of knowledge. Regional developments and adult education are not, and never can be, the universities' first concern, and the extent of the universities' participation in all such extra-mural activities must be determined by the extent to which they are consistent with the maintenance of the highest standards in the universities' primary activities.

THE FIRST AMERICANS

Early Man in the New World

By Kenneth Macgowan. Pp. xviii+260. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1950.) 37*s*. 6*d*. net.

THE evidence for early man in America, before the development of the traits connected with agriculture and a settled life, has hitherto been scattered in a number of technical publications, many of them difficult of access to readers in Great Britain. This book presents the material in a manner both popular and scientific. Mr. Kenneth Macgowan, distinguished in other fields, is an amateur anthropologist; but the book shows that he has read both widely and critically, and the result is clear and generally accurate.

In a book of this length, it is at first surprising to European readers to find forty pages devoted to Old World prehistory; but this is clearly necessary when addressing a public unfamiliar with that field. The author is critical of Mortillet's classification of the Palæolithic, which he regards as a scientific straitjacket; but it has done good and necessary service even if it has been applied too rigidly, and in the final chapter, which is admittedly speculative, he himself seems to look with too favourable an eye on reports of specifically European types of Palæolithic implement (bearing Mortillet's names) in the New World. He places Harrison, of Eolith fame, in Suffolk instead of Kent, and does not know that Oakley's fluorine analysis work has ruled out an early date for Piltdown man; but these are minor points.

The best source of information on early man in North America is a handbook by H. M. Wormington published by the Denver Museum of Natural History, which appears in the bibliography. This author has, with good reason, abandoned the term Yuma altogether; but it must be noted that Mr. Macgowan has retained it, apparently on purpose. Apart from this, the information given for all parts of America is up to date and, in most cases, as full as the nature of the book demands, though rather more might have been made of Junius Bird's work in south Chile, and his presumed early pressure-flaking sites on the coast of Peru are worth a mention. In connexion with the supposed find of mastodon in association with pottery near Quito in Ecuador, it is certainly a pity that the site did not get more satisfactory investigation (p. 145). Jijon y Caamaño, a distinguished Ecuadorian archæologist, told me that he had the gravest doubts about the association, and dated the pottery as late as the twelfth century. If mastodon had survived until this late date, other evidence of its presence should surely have been found by now either in Ecuador or Peru. The find was described by Uhle, who was concerned in it, and the mention of Maya influence on the pottery is a reminder of the extremely speculative nature of his writings at this time.

Some of the later chapters, containing discussions of diffusion, with special reference to Gladwin's views, and of agriculture, are interesting and stimulating, but relevant rather to a time later than that of the main theme of the book. Chapter 11 contains a statement (p. 208) that no maize had been found with the Coastal Chavin culture, which is not true, since Bird specifically states that it appeared at this very time. Further, we have, since 1949, had more precise information about the date of the appearance of this culture and of maize than is given here, in the shape of a radiocarbon date of 2665 ± 200 years, or about 700 B.C.

The book deserves to be widely read. Not only does it present a large body of information in a readable form, but also it is written in such a way as to encourage its readers to assimilate new facts and to make their theories fit them.

G. H. S. Bushnell

ELECTRONIC THEORIES OF ORGANIC CHEMISTRY

Physical Aspects of Organic Chemistry

By Dr. William A. Waters. Fourth edition, completely rewritten. Pp. xii+539. (London: Routledge and Kegan Paul, Ltd., 1950.) 35*s*. net.

WHEN the first edition of this book appeared, the application of the wave-mechanical treatment of electron behaviour to organic molecules was in its infancy, the concept of hyperconjugation was unknown, the duality of mechanism of substitution and elimination reactions was generally unsuspected, little was known regarding the kinetics of aromatic substitution, and free-radical chemistry was largely restricted to the reactions of more stable radicals like triphenylmethyl. The very great advances in our knowledge of these topics alone, during the past fifteen years, indicate the magnitude of the task involved in the up-to-date revision of this book which Dr. W. A. Waters has attempted in the fourth edition.

The scope is wider than the title might suggest, since the author attempts the application of "the broad conclusions of the electronic theory of valency" to all the principal reactions of organic compounds. Although the size of the book has been increased by some fifty pages, it is obvious that only the more salient features of such a wide field could be included, and this new edition constitutes a very readable and valuable survey of the present theoretical outlook. The impression is gained, however, that the author has been somewhat hampered and circumscribed by the original framework of earlier editions. There is an unhappy blending of different nomenclatures, and the treatment of some topics is not as up to date as might be expected. The intentional historical development of current ideas from their earlier and cruder precursors is valuable, but curtailment of such treatment would have permitted fuller elucidation and the presentation of a more accurate and complete picture of the conclusions derived from recent extensive kinetic studies.

Thus the whole treatment of ester hydrolysis is based essentially on Lowry's termolecular mechanism which, since it envisages proton-transfer from acidic to basic oxygen as a rate-determining step, would find very limited acceptance to-day. In consequence, Day and Ingold's mechanism of acid-catalysed ester hydrolysis is erroneously described (p. 347) as a bimolecular electrophilic substitution S_E2. Restriction of the account of the effect of substituent groups in 1 : 2-eliminations to those governed by the Hofmann rule (that is, control by the inductive effect) is liable to confuse the reader when he encounters similar eliminations which follow the Sayzeff rule (control by the electromeric effect). A strange and

unexpected confusion runs right through the book in the misnaming (p. 436) of the polarizability effect which arises from the reagent-stimulated delocalization of π-electron pairs, as the 'inductomeric' instead of the 'electromeric' effect. Moreover, this nomenclature is erroneously ascribed to Ingold, who, in the reference quoted, clearly assigns the term 'inductomeric effect' to the polarizability effect which corresponds to the *electrostatic* polarization known as the inductive effect. The same erroneous terminology is ascribed (p. 71) to Baker and Nathan's concept of the delocalization of the C—H bond electron-pairs of the methyl group in toluene (now known as hyperconjugation), although these authors, again, recognized its true character and designated it by the same nomenclature—namely, mesomeric and electromeric effects.

In spite of such defects and of a number of misprints, which although not numerous are sometimes rather confusing, the book is a valuable account of the physical background and development of modern electronic theories of organic chemistry and will doubtless be welcomed by all interested in this field.

J. W. BAKER

PLANT PATHOLOGY

Plant Pathology

By Prof. John Charles Walker. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. x+699. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 64*s*.

ALL students of plant pathology will welcome this work by Prof. J. C. Walker, the distinguished plant pathologist in the University of Wisconsin. It is an introduction to the scientific foundations of the subject, and forms a comprehensive treatment of the better-known plant diseases which may serve as a guide to the general principles of plant pathology.

It is, of course, a matter of personal opinion whether the arrangement of the matter in the book is actually the right one to adopt in such an introductory treatise—whether the sequence should be from the 'particular' to the 'general', or vice versa—but there are obvious drawbacks to the former method, which is the one chosen in this work. Following an introductory chapter on the definition of disease and disease terms and on the classification and economic significance of plant diseases, the reader is taken in the second chapter to a discourse on the history of plant pathology. One doubts, however, whether a student new to the subject can appreciate this information, excellent though it be, at this early stage; and it would perhaps have been more profitable to have extended the number of specific diseases described, especially those of trees, with a few others attributed to the Ascomycetes, which are relatively meagrely treated. At the outset, the young plant pathologist is often far more interested in handling the elements of the subject, the different kinds of fructifications and spores, of sclerotia and rhizomorphs, of morbid anatomy and culture work, than in a contemplation of the historical aspects of the subject. Such a dissertation would perhaps be better reserved for a riper stage of experience.

As a study of this subject must obviously go hand in hand with practical work in the field, greenhouse and laboratory, it is very doubtful whether a start on specific types of disease should have been made with non-parasitic diseases. The multiple symptoms usually presented by these maladies are often very difficult to assign to specific causes, and this section would have been better left until the student had gathered as much information as possible about diseases ascribed to specific organisms capable of being isolated in culture or examined in the plant tissue.

Succeeding chapters are devoted to diseases incited by bacteria (eleven types, with a useful key to the main genera); by Plasmodiophorales (two types); by Phycomycetes (fourteen types, preceded by definitions, but no illustrations, of the diverse kinds of spores and organs in this group); by Fungi Imperfecti (twelve types, prefaced by a scheme of classification in which are included several 'imperfect' forms belonging to the Ascomycetes); by Ascomycetes (thirteen types, with a classificatory outline); and by Basidiomycetes (thirteen types, embracing a number of the smuts, bunts, rusts, *Rhizoctonia*-diseases, and only two diseases of trees). Chapters 10 and 11 deal briefly with phanerogamic parasites (mistletoe and dodder) and nematodes, respectively. These are followed by a comprehensive and excellent account of virus diseases. Other chapters are devoted to the relation of environment to disease development, and host–parasite interactions (this might well have appeared much earlier in the book). Disease control is admirably treated at length in the concluding three chapters under the respective titles, exclusion and eradication, protection, and host resistance.

All the sections and individual types are supplemented by full bibliographies of titles and references. The entire work is beautifully executed (a few typographical errors occur) with 194 figures in line and half-tone, and forms a valuable contribution to the modern aspects of plant pathology.

S. G. JONES

UNCONVENTIONAL HYDRODYNAMICS

Hydrodynamics

A Study in Logic, Fact and Similitude. By Garrett Birkhoff. Pp. xiii+186+3 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1950.) 22*s*. 6*d*. net.

THIS is a book of a very unusual kind, quite unlike any of the standard treatises on hydrodynamics. The author himself says that the material treated "involves a heterogeneous combination of destructive logical criticism, detailed experimental fact, and occasional mathematical sophistication, which may at first seem unpalatable to many readers". The first chapter, entitled "Hydrodynamical Paradoxes", gives many examples of plausible arguments which lead to conclusions opposed to observed facts. It is generally supposed that all these discrepancies between theory and observation are due to a single unjustifiable approximation, namely, the assumption of zero viscosity, but Prof. G. Birkhoff claims that there are others. One of the most disturbing is the possibility that very small causes may sometimes produce large effects. This calls urgently for an investigation into the nature of the corresponding partial differential

equations. There are also several cases where apparent symmetry in the causes produces unsymmetrical effects. This chapter is what George Bernard Shaw might have written if he had studied hydrodynamics. After pointing the fallibility of mathematicians, logicians, engineers and physicists, Prof. Birkhoff concludes the chapter with a warning, supported by a photograph forming the frontispiece, against trusting in common sense.

The second chapter, entitled "Recent Progress in Free Boundary Theory", is somewhat similar to the first, but is more constructive and contains some new positive contributions to the subject. It includes an account of two physical parameters which are completely ignored in the classical theory of jets and wakes. The third chapter deals with the use of small models to predict the behaviour of full-scale apparatus, and begins with "a number of simple, yet fundamental mathematical remarks which have hitherto escaped general attention". The author distinguishes between dimensional analysis and inspectional analysis. The former is widely used, but he points out its limitations, which seem to be overcome in the latter. However, for a complete inspectional analysis of hydrodynamical modelling we need fundamentally new theorems about partial differential equations. It is possible that these will be suggested by a study of experimental results. Inspectional analysis is really an application of the mathematical theory of groups, which can also be used to test the validity of hydrodynamical theories even when it is impossible to integrate the corresponding partial differential equations. In the fourth chapter the reader will at last realize that the author's main object is to emphasize the importance of group theory, which is presented as a unifying principle, not only in hydrodynamics but also in other branches of physics and in the theory of differential equations. This is illustrated by a variety of important problems. The fifth and last chapter applies group theory to the concept of 'virtual mass'.

The book will be of great value to those who are able to use it to stimulate their own thoughts.

H. T. H. Piaggio

QUAKERS IN SCIENCE AND INDUSTRY

Quakers in Science and Industry

Being an Account of the Quaker Contributions to Science and Industry during the 17th and 18th Centuries. By Dr. Arthur Raistrick. Pp. 361+17 plates. (London: Bannisdale Press, 1950.) 21*s*. net.

MUCH research has gone into the making of this book, and its preparation has evidently been a labour of love for the author. It covers especially the period 1650–1800, during which Great Britain changed over from an economic structure largely agricultural in character to one in which large-scale basic industries, such as coal-mining, iron-founding and engineering, were playing a rapidly expanding part.

About the middle of the seventeenth century, George Fox founded the Society of Friends, soon to be dubbed Quakers. The sect soon attracted unfavourable attention from both the Established Church and the State. Yet, such was the intellectual and spiritual force behind the movement that, in spite of the disabilities imposed on it by law, and the persecution to which members were subjected, its numbers expanded rapidly. Dr. Raistrick points out that before the eighteenth century was well advanced, Quakers occupied influential positions in basic industry, trade, banking and medicine, and appeared on the roll of the Fellows and Council of the Royal Society.

In the first two chapters the author traces in some detail the rise of the Quakers, and the part they played as citizens; and shows by means of statistical evidence that they sprang largely from the class that provided craftsmen, artisans and yeomen. Later, however, they became predominantly middle-class traders.

The next six chapters describe the part played by the Quakers in trade and industry. Among the traders singled out for special mention are the iron masters and the mining companies, including the Quaker Lead Co., which dominated lead mining in Britain during the eighteenth century. The Quakers were prominent in other metal industries, such as brass founding and the smelting of copper and zinc; and reference is also made to the wool staplers and linen drapers. The English porcelain industry, which grew out of the discovery of the china clay deposits in Cornwall, was founded by a Quaker, William Cookworthy.

Dr. Raistrick then discusses the part taken by the Friends in technology, science and medicine. The famous clock- and watch-makers Thomas Tompion and Daniel Quare were Quakers, and so was George Graham, who also constructed a number of astronomical instruments for Greenwich Observatory.

The Friends regarded all natural objects, plant, animal and mineral, as the works of a beneficent creator, to be studied and used for the benefit of mankind, so that it is not surprising to find among their numbers some prominent naturalists and men of science. These included Phillip Miller, superintendent of the Physic Garden in Chelsea, and author of the well-known "Gardener's and Botanist's Directory" published in 1731; William Allen, chemist; William Phillips, mineralogist, and one of the founders of the Geological Society of London, and, most distinguished of all, John Dalton. Among Quaker medical men there occur the names of John Fothergill and John Coakley Lettsom.

During the eighteenth century there was widespread intermarriage among the Quakers, and the family relationships and business ramifications were closely interlocked. The latter pervaded industry throughout England and Wales, and even penetrated into Scotland and Ireland. Many names additional to those quoted here, some important, others less so, receive a mention in this book, and there is a wealth of genealogical and biographical information; but sufficient has been said to indicate its scope.

In the final chapter the underlying causes responsible for the remarkable rise of the Quakers are discussed. Prominent among these were their honesty in business dealings, their lack of avariciousness, and their genuine and practical interest in the welfare of their employees.

Dr. Raistrick's book is fully documented, and is a valuable contribution to the social and industrial history of the years between 1650 and 1800, adding also to our knowledge of the development of technology in that period. It should be read by all to whom such matters are of interest. V. A. Eyles

THE NEW UNIVERSAL DIGITAL COMPUTING MACHINE AT THE UNIVERSITY OF MANCHESTER

By Dr. T. KILBURN
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IN a previous communication[1], a universal digital computing machine was briefly described. That machine was experimental, and its purpose was mainly to investigate the potentialities of a large-scale machine based on the cathode ray tube[2] and synchronized magnetic drum[3] type of storage. The success of the machine made it possible to begin the design in July 1949 of a new machine, which has just come into service. Whereas this new machine is superficially the same as the experimental machine in that it operates serially, uses the binary system of numbers and has the same digit frequency of 100 kc./s., it has several improved features.

Storage. Experience of the experimental machine showed that the electronic storage capacity of 5,120 digits provided by two cathode ray tubes was rather too small to permit flexibility of programming, and that the subsidiary storage on the magnetic drum of 40,000 digits would be quite inadequate for many problems. In the new machine the electronic storage capacity has been increased to 10,240 digits, and improved operation of the store has been obtained by halving the number of digits stored per tube, and by using the defocus–focus system of storage[2]. The magnetic storage capacity has been increased to 150,000 digits, provision being made for a further increase to a maximum of about 600,000 digits if this is necessary. The magnetic drum is 6 in. in diameter, and along its length of 8 in. there is sufficient space to accommodate 256 separate peripheral tracks. Each track holds 2,560 useful digits; the packing density being 165 digits per inch. The mechanism of reading from and writing on these tracks is described elsewhere[4]. The electronic store can be automatically loaded from, or into, the magnetic store as a result of programmed instructions. These instructions cause a transfer of information in which the contents of any stated track are written on a stated pair of cathode ray tubes or vice versa. Alternatively, if it is more convenient, the transfer of information may be between one half-track and one cathode ray tube. In each case, the correctness of transfer can be checked by a single instruction, and, in the case of an incorrect transfer, the transfer can be repeated, or the machine stopped.

Selection of a particular track for reading is by electronic switching, and for writing, by relay switching.

The time taken for the check, and for any transfer, in which a track is read, is 36 msec. For a transfer in which information is written into a track, this time is increased to 63 msec. to allow time for the relay switching. This discrepancy between the times for reading and writing is not important, because reading is more frequent than writing. This is so because the sub-programmes required during computation are all stored on the magnetic drum.

The accumulator. The facilities for performing addition, subtraction and three logical operations have been retained, together with signed and unsigned multiplication, in which the 80-digit product of two 40-digit numbers is added to the content of the accumulator. Multiplication in which the product is subtracted from the accumulator is a new facility.

The most important engineering change of the accumulator is in the multiplying circuit. In the experimental machine the multiplication time, which depended on the number of 1's in the multiplier, averaged about ten times that for addition. A study of available programmes revealed that if this multiplying circuit was used in the new machine, then about half the computing time of the machine would be spent in multiplication. Consequently, the speed of multiplication has been increased, and, in the new machine, an instruction involving multiplication is selected, interpreted and obeyed in 2·16 msec., as compared with a corresponding time of 1·2 msec. for addition, or any other 40-digit number operation. The increase in speed of multiplication is obtained by using a circuit consisting of a network of adders and delays, arranged in such a way that the sub-products are added together in one operation, instead of sequentially. Although some economy of equipment is achieved by carrying out the multiplication in two parts, controlled respectively by the first and second halves of the multiplier, nevertheless this type of multiplier is expensive and increases the size of the final machine by about 10 per cent (the machine contains 1,600 pentodes and 2,000 diodes). This, however, is judged to be worth while when balanced against the resulting overall increase in speed of operation of the machine.

To simplify the standardization of numbers during the course of computation, an instruction has been provided which produces in the accumulator a statement in binary form of the position of the most significant digit of any selected number in the electronic store.

In the near future, an additional circuit will be installed to generate (in 5·8 msec.) a 20-digit random number as a result of a single instruction. This instruction will be used in calculations concerned with stochastic processes.

The B tube. This facility has been improved to allow still greater flexibility and economy in programming. Eight 20-digit storage locations can now be selected by the three '*b*-digits' of an instruction, and thus any one of eight words may be added to an instruction before it is used.

Further, the *B* tube has been provided with a subtracting circuit, and a sign-testing circuit. Any line of the tube can therefore be used as a 20-digit accumulator for simple arithmetical processes. One important example of this is in counting the number of times that a group of instructions has been obeyed, cycling of control being conditional on the sign of a number in the *B* tube. By this means four instructions are removed from any loop in which counting is required.

The instructions provided enable a number from the electronic store to be written into, or subtracted from, the *B* tube; or a number in the *B* tube to be

written into the electronic store. The line of the *B* tube involved in these instructions is stated by the three '*b*-digits'. To avoid the necessity for eight test circuits—one for each line—the instruction 'test the sign of *B*' reads a single circuit, which is recording the sign of the content of that line of the *B* tube which was last used.

The time taken to read, interpret and obey these instructions is 960 microseconds.

Input and output. The input and output is based on teleprinter apparatus using 5-hole paper tape. The input uses a photo-electric tape reader capable of reading 200 five-digit characters per second. The output is by a mechanical tape-punch and/or teleprinter each capable of printing ten characters per second.

The speed of input is approaching the maximum for this machine if an input programme is required to organize the input information. However, the speed of output, which is twenty times as slow, can only be justified if, in general, the time of output is smaller than, or comparable with, the input and computing times together. If this proves to be untrue, an alternative scheme for input and output which has been designed around punched cards may be incorporated at a later date.

Speed of operation. The basic rhythm of the machine is determined by the length of the 20-digit instruction, and not by the length of the 40-digit number. This increases the speed of operation of the machine, as compared with that of the experimental machine, by a factor between 1·8 and 2. If the improvements to the *B* tube, multiplier and other parts of the machine are also included, the overall increase in speed is probably not less than a factor of 3.

It should be noted that this increase has been obtained largely by reorganization, and not by the more difficult and expensive method of increasing the fundamental digit frequency.

Programme of work. It is not proposed to limit the programme of work on the machine to any particular type of problem, but to cover a range of problems chosen for their diversity. Thus, in the immediate future the following items are among those which will be investigated: (1) partial differential equations arising out of biological calculations; (2) simultaneous linear differential equations and matrix algebra, and their application to the cotton and aircraft industries, and electricity distribution; (3) tabulation of Laguerre functions; (4) design of optical systems; (5) Fourier synthesis for X-ray crystallography; (6) design of plate fractionating towers; (7) chess problems.

One aspect of the design of machines is to decrease the number of thermionic valves they contain. Thus, for example, it may be said that in the present machine the multiplication time is too nearly equal to the addition time, and that the size of the machine could be decreased by using a simpler multiplier, say, four times as slow in operation. However, with the present input speed of 1 character every 5 msec., it would then be impracticable to programme the input. One method of overcoming this would be to build circuits to organize the input data; not only would this reduce the flexibility of the programming method of input, but it would also nullify the original intention, which was to reduce the size of the machine. This argument can be extended to include other aspects of design such as the relative merits of serial and parallel machines, various forms of storage and so on. It can be seen that all aspects of machine design are related in a most intricate way, and because of this, the design of present machines has to be based to a great extent on the personal experience and intuitions of the individual designer. Consequently, one further important problem which the machine itself may solve is that when fed with input data describing the reliability of circuits, valves and other components, the speeds of operation of the various possible parts, and all other relative factors, it will give a more correct answer to the problem which still confronts engineers, namely, the design specification of the optimum universal computing machine.

The work described in this article is part of an investigation carried out jointly with Prof. F. C. Williams, in the Electrical Engineering Laboratory of the University of Manchester. I wish to acknowledge the assistance of Mr. G. C. Tootill and the members of the Computing Machine Laboratory and of the members of staff of Messrs. Ferranti, Ltd., who collaborated in the development, and who constructed the machine.

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NATURE AND INFECTIVITY OF GRANULAR FORMS OF THE BOVINE TUBERCLE BACILLUS

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THE part played by the 'granular' forms of the tubercle bacillus in the infective process and their place in the life-history of the mycobacterium are still matters of controversy. At present there is a tendency to regard them merely as by-products, seen in old cultures, or as atypical forms produced under unfavourable growth conditions. The question whether the granules are a kind of microspore[1,2] liberated from the mature bacillus, or whether they are merely short rudimentary rods[3,4], has yet to be decided.

The granular forms first described by Much[5] and known as 'Much's granules' have a more definite character. In staining characteristics they are non-acid-fast but Gram-positive. They are said to predominate in tuberculous lesions in which acid-fast bacilli are difficult to find. For a long time Much's granules were regarded as an alternative form of the tubercle bacillus. To-day one is more inclined to regard them as some kind of degenerate form.

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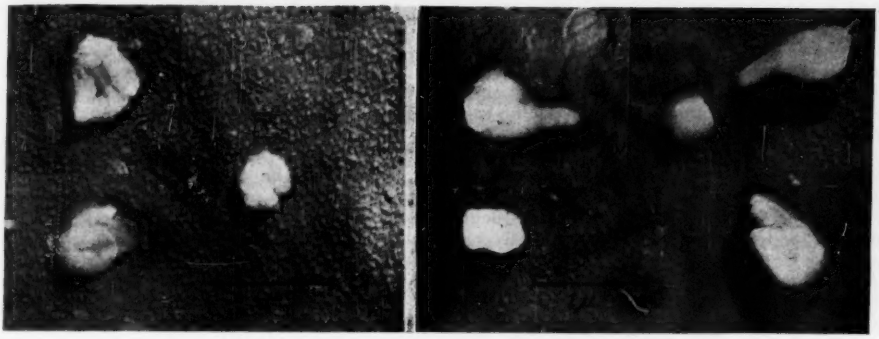

Fig. 1. Granules of 0·5–1·0 μ in size, contained in extracts of high infectivity from rabbits inoculated with *Myc. tub. (bovis)*. Shadowed with gold-palladium; negative print. Original magnification, 18,000 ×; reproduction, 18,000 ×

Fig. 2. Granules of similar origin and size, but with a projecting rodlet. Preparation and magnification as for Fig. 1

The electron microscope would be expected to reveal the presence and structure of submicroscopic forms, and yet in the few publications on this subject the presence of free extra-cellular granular elements has been seldom mentioned. Intra-cellular granular bodies were described in avian tubercle bacilli by Lembke, Ruska and Christopherson[6], and von Borries[7] interpreted similar structures as Much's granules on rather scant evidence. Brieger and Cosslett[8] found with an avian strain that the dense bodies seen inside the cytoplasm undergo characteristic changes in the first three days of incubation, but there was no definite evidence that free granules occur or that bacilli can develop from free granules. Experiments which are now in progress, employing the technique of differential centrifugation directly on to grids, may throw more light on this intricate problem.

Experiments to demonstrate the presence of granular elements in extracts of infected tissues have been more successful. In recent work by Brieger, Fell and Smith[9], it was shown that tissues removed from rabbits at various intervals after infection with a bovine strain contained only very few acid-fast bacilli, although showing extensive histological changes. If, however, explants of these tissues were cultivated *in vitro* (as tissue cultures), large numbers of bacilli appeared inside healthy-looking macrophages. After about ten days of cultivation *in vitro*, the whole explant became a conglomeration of bacillary colonies. These results showed the need for re-examining the question whether the macrophages, later to become the hosts of large numbers of bacilli, are not, in fact, heavily infected with pre-bacillary elements, which are not demonstrable by present staining techniques.

Fulton and Begg[10] have shown that extracts from tissues infected with rickettsia can be so purified that an opalescent fluid is obtained, after differential centrifugation, which is an almost pure suspension of the organism. Using the same method, Cosslett, Miles and Stoker[11] purified Nigg's virus from infected lungs and spleen of mice. We have now applied the Fulton and Begg technique to the spleens and lungs removed from rabbits seven to twenty-one days after intravenous infection with a virulent bovine strain. Acid-fast bacilli were no longer demonstrable in the fluid obtained after purification and differential centrifugation. In none of the six experiments performed did the electron microscope, phase-contrast microscope or staining methods reveal elements which could be identified as bacillary rods. In itself this would not be sufficient proof that all bacillary elements were eliminated in the process. However, we were also unable to reproduce bacilli by culturing the fluids on a wide variety of media, in spite of long periods of incubation. Microcultures on coverslips did not show any sign of bacillary growth, except in one experiment in which a new and very virulent bovine strain was used. In this case a few acid-fast elements were seen in stained preparations after prolonged incubation.

In spite of the failure to demonstrate acid-fast bacilli, inoculation of a small amount of the fluid (0·2 ml. of a 1 : 5 dilution) into the subcutaneous tissue of the legs of guinea pigs produced a glandular abscess in the draining glands in the course of four to six weeks. Large numbers of acid-fast bacilli were present in the pus, the spleen was heavily infected and a generalized tuberculous infection was present.

The highly infective fluid extracted from the rabbit organs was fixed in osmic acid and samples were placed on metal grids and examined in the electron microscope. Two types of particles were seen: (*a*) particles of about 0·5 μ size or larger; (*b*) small round particles of about 0·2 μ diameter. The larger bodies were obviously related to bacterial elements.

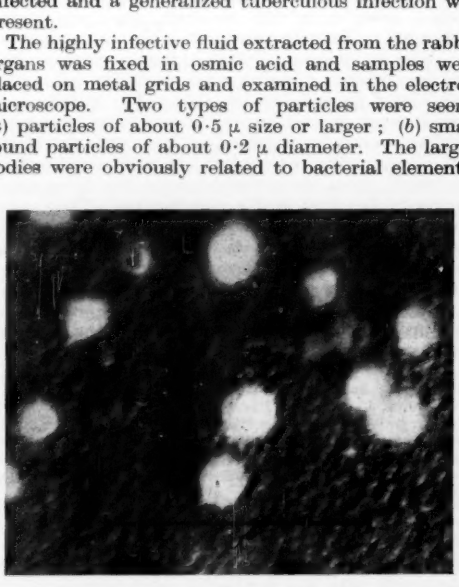

Fig. 3. Granules of 0·1–0·25 μ in size, obtained and prepared as those in Figs. 1 and 2. Original magnification 36,000 ×; reproduction, 41,000 ×

Some had a structure which suggested a set of tightly-packed microrods (Fig. 1). Others had finger-like protrusions and seemed to represent an intermediate stage between granular and bacterial forms (Fig. 2). While the larger particles showed these structures, which distinguished them from contaminants or tissue remnants, the smaller ones (Fig. 3) resembled the smaller animal viruses in size and structure. They were not found in controls prepared from healthy tissues; but it cannot be excluded that they may be normal constituents which are released from cells in pathological conditions.

The fluid was filtered through 0·725 μ A.P.D. 'Gradocol' membranes (which retained *Bac. prodigiosus*) and then did not produce definite tuberculous lesions in guinea pigs. The results of transplanting the glands into normal animals are not yet available[12].

At the present stage, the interpretation of the results must be made with some reserve. Although the presence of normal acid-fast bacilli could only be finally excluded by dilution tests, we may tentatively infer that infection can be caused by particles which are too large to pass the filter but which are not normal rods. These particles may well be identical with Much's granules; our observations show them to have some internal structure. On the other hand, it may be that the smaller particles passed by the filter are essential stages in infection but are unable to produce infection by themselves. In order to build up into the larger, infectious particles, they may require the presence of the living host cell. If this is so, their isolation would break the normal cycle of development in the tissues of the living host.

The fact that the living host cell is necessary for the reproduction and survival of even the larger particles is suggested by the difficulty of culturing them. In one case, when the fluid was injected into a normal rabbit spleen which was afterwards cultured *in vitro*, massive growth occurred, after two weeks incubation, in the juice surrounding the tissue culture. In no case has it been possible so far to grow colonies from the filtrates containing the particles, using the conventional bacteriological media. For this reason, as well as on morphological grounds, the granular particles cannot be regarded as a variant bacterial form, as normally understood. It may well be that they result from the breakdown of the inoculated bacteria in the first stages of infection. They may develop directly into the new generation of bacillary rods which appear at a later stage, or the larger granules may be an intermediate form in such a development, a possibility put forward by Much in his last contribution to the subject[5]. Some of the many problems raised by these observations are now being investigated.

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WILLIAM NICOL AND HENRY CLIFTON SORBY: TWO CENTENARIES

By JOAN M. EYLES

AMONG the various sources of information available to the geologist, rock sections, cut so thinly that they can be examined under the microscope by transmitted light, are particularly valuable. The year 1951 marks two centenaries of especial interest in the early history of this technique.

William Nicol, who died in 1851, was not only the inventor of the well-known Nicol prism, which later became an essential tool in examining rock sections by polarized light, but he was also a pioneer in the making of thin sections. Nicol seems to have confined himself to making sections of fossil wood, and did not make rock sections. H. C. Sorby was the first to do this, and it was in 1851 also that his first paper in which such sections were described was published in the *Journal of the Geological Society*. This paper bore the title "On the Microscopical Structure of the Calcareous Grit of the Yorkshire Coast", and, though epoch-making in retrospect, seems to have attracted very little attention at the time.

William Nicol, who was a teacher of physics in Edinburgh during the early part of the nineteenth century, described the construction of his polarizing prism in 1829[1]. Two years later, in 1831, Henry Witham published his "Observations on Fossil Vegetables", in which are given the earliest illustrations of fossil wood seen in thin section under the microscope. In this work Witham gave credit to Nicol for the method of preparing these sections. While the actual technique of cutting the material was no more than that developed by the lapidiaries in cutting precious stones and agates, etc., Nicol seems to deserve the credit for realizing it would be of scientific interest if applied to fossil wood. Further than that Nicol apparently did not go, although it seems only a short step from sections of fossil wood to sections of rocks in general. Nicol left his own collection of sections in his will to his friend Alexander Bryson, of Edinburgh, who was himself skilled in making sections, and added to the collection. Nicol's name does not appear in the "Dictionary of National Biography", but there is a memorial tablet in Warriston Cemetery, Edinburgh, which bears the inscription: "In Memory of William Nicol—1766–1851—Inventor of the Polarizing Prism everywhere known by his name".

Turning now to Sorby, he himself, in a lecture entitled "Fifty Years of Scientific Research"[2], said he learnt the art of making thin sections from W. C. Williamson, then a surgeon in Manchester, but later to become first professor of natural history at Owens College and a well-known palæobotanist. Williamson was the grandson of a lapidiary, and as a youth was familiar with the lapidiary's art; and as he was working on fossil teeth and other siliceous material during the eighteen-forties, there seems no reason to doubt Sorby's statement. Sorby said also that the idea of applying the technique to study the structure of rocks came to him in 1849, and he immediately set about preparing such sections; this led to the paper sent to the Geological Society and published in 1851. In spite of this, it has several times been stated by well-known writers, such as Sir Archibald

Geikie, that Sorby got the idea of making rock sections from examining Nicol's collection in Edinburgh in 1856, when it was in the possession of Bryson. The facts, as stated above, were given by J. W. Judd in various obituary notices, but seem to have been disregarded, or even contradicted. The misconception may have arisen because Sorby, in 1857, presented to the Geological Society an important paper on the microscopic structure of rock-forming minerals, and in it referred to Bryson's collection; but if this is the reason, then it shows how little attention Sorby's earlier paper had attracted.

It is therefore worth recalling that Sorby, in his 1851 paper, had employed methods which are now familiar to every petrographer. His sections, mounted in Canada balsam, were "not much thicker than one-thousandth of an inch". He used polarized light, and rotated his specimens between crossed nicols to distinguish between calcite and quartz. In addition to examining thin sections, Sorby separated the constituents of the calcareous grit by chemical and mechanical means. He did not describe in this paper his manner of preparing the sections, but later gave a very clear account in a lecture to the Geological Society of France, in 1860[3]. This latter account was also published in Germany and Spain. Two years after this lecture had been given, Sorby met Ferdinand Zirkel, and described to him his petrographic methods. This encounter was to have far-reaching consequences, for Zirkel took up this type of work with enthusiasm, and in the following year read to the Vienna Academy a memoir describing the microscopical features of thirty-nine different rocks. Subsequent work by Zirkel, Rosenbusch, Fouqué and Michel-Lévy established microscopic petrography as an important branch of geological science, although in the land of its birth it made slower progress than abroad.

In this centenary year of the first account of rock sections, it would therefore be of especial interest if attention were directed to the anniversary by the exhibition in museums of any suitable material. Sorby was so frequently a contributor to the meetings of the British Association that such an exhibit would be particularly appropriate at this year's Edinburgh meeting, where the names of Nicol and Sorby could be fittingly coupled.

[1] *Edin. New Phil. J.*, **6**, 83 (1829).
[2] *Sheffield Lit. and Phil. Soc. Rep.* (1898).
[3] *Bull. Soc. Geol. de France*, **17**, 571 (1860).

OBITUARIES

Mr. H. A. Humphrey

Mr. Herbert Alfred Humphrey, who died at the age of eighty-two in South Africa on March 9 of this year, was one of the most versatile British engineers of recent times. He was best known as inventor in 1908 of the Humphrey pump, which is an internal combustion engine in which the piston is replaced by a water surface. It became an effective means of pumping large volumes of water; the Chingford Station of the Metropolitan Water Board has a set of four large and one smaller Humphrey pumps of 180 million gallons a day total capacity. During the course of his consulting work as a civil, mechanical and chemical engineer, Humphrey had opportunity for exercising his inventive talents in many directions, particularly in the field of gas engines and producers; but not only in a professional capacity, for he would also amuse himself at home in his well-equipped workshop with many devices arising from his fertile imagination.

Humphrey was a distinguished Old Centralian, having been trained as an engineer at the Finsbury Technical College and during 1885–87 at the Central Institution, South Kensington (now the City and Guilds College). There he came under the influence of Unwin, Ayrton, Armstrong and Henrici. He entered in 1887 the works of Messrs. Heenan and Froude as assistant to R. H. Heenan, later becoming manager. In 1890 he was appointed engineer and departmental manager in the Winnington works of Messrs. Brunner Mond and Co., where his ability was soon appreciated by Dr. Ludwig Mond. Until 1901 he remained at Winnington, but thereafter acted with Mond's encouragement as an independent consulting engineer. On account of his work on gas engines and the well-known pump, he soon established a reputation extending to many other countries. He was, however, chiefly concerned with the chemical engineering developments in Brunner Mond's and its associated companies, and later in Imperial Chemical Industries, Ltd., into which these companies were merged. Among other developments he was responsible for erection of coke ovens, benzol extraction plant, caustic soda works, application of gas engines to power generation, and, during the First World War, T.N.T. and ammonium nitrate plants. After that War, he was consultant in the construction of the Billingham plant for synthetic ammonia, for the designs of which he was largely responsible. It was a project on the grand scale, involving a capital expenditure of £25 millions. The boiler and power plant at Billingham, completed in 1929, was well forward of central power station design in Great Britain at that time. He retained a close consulting connexion with Imperial Chemical Industries until late in life. He was also chairman of the South Staffordshire Mond Gas Co., the plant of which he designed.

It was only about two years ago that Humphrey left England to reside at Hermanus, Cape Province, and even there at the age of eighty he was still exercised in several engineering schemes.

The First World War found Great Britain very ill prepared in the supply of explosives, and Lord Moulton, who was chairman of the Explosives Committee, early realized that a great expansion of chemical manufacturing capacity was required. Humphrey was one of the very few engineers available who had the necessary experience in chemical engineering, and through Brunner Mond's he was brought into the organization that Lord Moulton set up. He was responsible for many of the developments which saved Britain from disaster and helped to give an impetus to British chemical industry, which has ever since thrived and expanded. K. B. Quinan was leader of the Explosives Department's constructional programme; he, however, was an American subject, a chemical engineer who came from South Africa. To such men Britain owes a deep debt of gratitude. Humphrey described in the Melchett Lecture to the Institute of Fuel the activities with which he was connected in those days.

Humphrey's influence in training men as chemical engineers within the I.C.I. organization, and insisting on a fundamental approach to the engineering problems encountered, had a great effect on the efficiency of the whole industry. The benefit of his

wide experience was generously given to those working with him, and he endeared himself to them.

Humphrey received a number of awards from the engineering institutions, the Willans (1906), the Watt (1913), and the Telford (1897) Gold Medals, the Franklin Medal of the Franklin Institute and the Paris Premium of the Institution of Electrical Engineers (1930). He had three sons and two daughters; one son married a daughter, and one daughter married a son, of Prof. A. V. Hill. He was a member of all three engineering institutions, Civil, Mechanical and Electrical; a Fellow and Melchett Medallist (1939) of the Institute of Fuel, and an honorary fellow of the Imperial College. A. C. Egerton

Dr. D. F. Twiss

By the death on May 23 of Dr. D. F. Twiss, the rubber industry has lost a distinguished pioneer scientific worker and a man universally esteemed by his colleagues in the industry. Born in Birmingham in 1883, Douglas Frank Twiss studied at Mason College and its successor, the University of Birmingham, where he graduated B.Sc. in 1902, afterwards carrying out research in organic chemistry under Prof. P. F. Frankland. During 1904–14 he was lecturer in chemistry at Birmingham Technical School (now Birmingham Central Technical College), and continued research work on organic sulphides and other sulphur compounds and selenides. Dr. Twiss became, indeed, a leading authority on the sulphur group of elements, and was joint author of vol. 7 (oxygen, sulphur, selenium, tellurium) of the well-known "Text Book of Inorganic Chemistry" edited by J. Newton Friend. He was awarded research degrees by the Universities of Birmingham (D.Sc.), and London (B.Sc.).

This early interest in sulphur and its organic compounds was a fitting preparation for Dr. Twiss's real life-work, which lay in the field of rubber chemistry, including vulcanization by sulphur. The opportunity to enter this field came in 1914 when Dr. Twiss was engaged by the Dunlop Rubber Co., Ltd., as its first scientific worker. During his thirty-two years as chief chemist there grew up under his leadership a research team that has made outstanding contributions to rubber science and manufacturing techniques.

Dr. Twiss's earlier work on rubber was concerned with vulcanization by sulphur, the action of organic accelerators of vulcanization, and the important influence of zinc oxide and other metallic oxides on their activity. Of even greater importance to the development of the industry, however, has been the work pioneered by Dr. Twiss on the production of rubber articles directly from the liquid latex, without the usual intermediate stage of coagulating to produce dry rubber which then has to be worked ('masticated') on heavy machinery to render it fit for further processing. From the work of Twiss and his colleagues on latex has developed an entirely new and important branch of the rubber industry, producing vast quantities of cellular (foamed latex) rubber for upholstery, as well as rubber gloves, thread, and hosts of other articles, using methods which in essence are of elegant simplicity, though demanding a rigid physico-chemical control over that complex and sensitive material, rubber latex.

In the midst of these activities Dr. Twiss yet found time to be a willing helper and wise counsellor to many organizations connected with the rubber industry, notably the Institution of the Rubber Industry and the Research Association of British Rubber Manufacturers. There are many who will remember with gratitude and admiration the unfailing help which Dr. Twiss's intensely logical mind was able to give on innumerable problems. Through his work for these organizations, Dr. Twiss did much to foster both technical education and co-operative research in the rubber industry. In recognition of his outstanding services, the Institution of the Rubber Industry in 1934 conferred on Dr. Twiss the Colwyn Gold Medal.

For a man of such attainments and influence, Dr. Twiss was modest and retiring to a degree, but his sincerity of purpose and his conscientious and painstaking discharge of any duty that he undertook—and these duties were many and varied—marked him out as a man above his fellows. His memory will always be an inspiration to those who had the privilege of knowing him. J. R. Scott

Prof. E. L. Watkin

The death of Ernest Lucas Watkin, emeritus professor of mathematics in University College, Southampton, has severed one of the few remaining links with the difficult time when the College was struggling not only to deserve the name of University College, but even to keep in existence.

Prof. Watkin took his degree from St. John's College, Cambridge, being seventh wrangler in the Mathematical Tripos of 1898, still remembered as 'Hudson's Year' for the galaxy of distinguished mathematicians who took the Tripos then. After a short time as lecturer in the University of Bristol, he was appointed in 1904 to the chair of mathematics at Southampton, which he held until 1930. Only those closely associated with him realized the burden of organization involved in a department in which many additional courses were necessary if the College were to survive, including heavy and increasing commitments to the technical side which is still part of the work of the College. He had great administrative ability, and though handicapped by persistent ill-health, carried out unflinchingly work which in these days would be shared by at least two people. His entire disregard of self brought him enthusiastic loyalty from his Department.

After retiring from the chair, he continued to act as deputy registrar and curator of the grounds of the College until increasing age and ill-health forced his permanent retirement.

Prof. Watkin's interests were unusually wide and all were useful to college life. He was an admirable gardener with a good knowledge of systematic botany which he was able to apply as curator of the grounds. He was president of the Chess Club, a strong supporter of all musical activities, an authority on the regulations of most varied and mixed bodies with examination and entrance requirements, and a repository of information on the past history of the College. He combined with all these a gift for friendship, a patient and understanding care for the difficulties of people who often proved tiresome and captious, and a loyalty to his chosen work which is past all praise. A. M. Trout

We regret to announce the death of Prof. W. E. Agar, C.B.E., F.R.S., emeritus professor of zoology in the University of Melbourne, on July 14, aged sixty-nine.

NEWS and VIEWS

Expedition to Greenland

A ROYAL Air Force Coastal Command flying boat, which is visiting Greenland in the course of routine flying training, is taking a small party to carry out a preliminary survey for a more ambitious expedition planned for next year, when geological, glaciological, meteorological and biological work will be carried out. The present expedition, which is privately sponsored and has the approval of the learned societies, including the Royal Society, the Polar Institute and the Royal Geographical Society, will spend a month to six weeks in Greenland. The party is led by Commander (L) C. J. W. Simpson, and will include Capt. M. E. B. Banks, Lieut. F. R. Brooke and Lieut. Angus Erskine. While surveys of the mountainous coastal ranges of Greenland have been nearly completed, little is known of the interior. It is, however, known that in the region called Queen Louise Land in lat. 77° N. there is a range of nunataks 100 miles long, 40 miles wide and rising to about 7,000 ft. To reach this range entails crossing a 20-mile wide glacier. This year's party intends to land on a long lake near the coast and to make its way by a rubber boat to the glacier. With the aid of a Greenland trapper and dog sledges, it expects to cross the glacier and survey a second lake about three miles long that lies along the eastern edge of Queen Louise Land. It is hoped to find on this lake a site for a base camp for further exploration next year, and to discover whether this lake would offer suitable landing for float planes which may be used by the main expedition. It is also intended to bring back geological specimens and to reconnoitre a suitable sledging route through the mountains to the inland ice lying beyond to the westward.

Major Visible Antiquities in Great Britain before 1066

THE Archæology Branch of the Ordnance Survey is to be warmly commended for producing a map of the principal visible ancient sites and monuments in Great Britain, of origin before A.D. 1066, which is designed not for the archæologist but rather for the tourist and all those interested in ancient history. The scale is 1/625,000 (or about ten miles to the inch), and this allows the map to be printed on two sheets, one for England south of the line running approximately from Scarborough to Windermere (and including the Isle of Man) and the other for the rest of England and Scotland (including the Scottish islands) (obtainable from the Ordnance Survey, Chessington, Surrey; 6*s*. 9*d*. each sheet). The map is in faded grey with the sites superimposed in black type, these being classified and marked with a distinguishing symbol according to the age group: Palæolithic, Mesolithic, Neolithic, Bronze, Iron, Roman, Dark Ages and uncertain; in addition, Roman roads and canals, and earthworks and frontier defences are shown. It must be stressed that in all cases the emphasis is on the visibility of the site or monument in question; thus, the only sections of Roman roads which are shown are those which are well preserved and recognizable as such and have not been merged into the modern road system. One or two exceptions to the rule of visibility have been made in the case of those sites which, though worked on and filled in, are exceptionally well known for the value to scholarship of the material they have yielded. As is pointed out in the preface to the sheets, the long forms of cairn and barrow have for the most part been allocated to the Neolithic period, and in the same way the round forms to the Bronze, a classification which is to some extent a convention but nevertheless a convenient one. The age group, 'Dark Ages', covers the period from the end of the Roman occupation up to 1066 and is necessarily a 'mixed bag'. Finally, a small number of museums of special interest have been marked, the most important of which is the Pitt Rivers Museum at Farnham. Both sheets contain an index of names for the whole map, and with each name is a brief description (one to a dozen words), age-group, Ordnance Survey sheet reference to the one-inch series of maps, and the National Grid reference point.

Israel National Committee for Theoretical and Applied Mechanics

AN Israel National Committee for Theoretical and Applied Mechanics has recently been formed, with Prof. M. Reiner and E. Traum (both of the Hebrew Institute of Technology) as chairman and honorary secretary-treasurer, respectively. An application for admittance as an adhering body has been submitted to the International Union of Theoretical and Applied Mechanics; Prof. S. Goldstein, previously of the University of Manchester and now vice-president of the Hebrew Institute of Technology, Haifa, is a personal member of the general assembly of the International Union. The Committee held a scientific colloquium in Haifa at the Hebrew Institute of Technology during April 23–24. There were two general lectures: Prof. Goldstein gave a review of the present state of the statistical theory of turbulence, and Prof. F. Ollendorf (Hebrew Institute of Technology) dealt with the mechanics of the trajectories of the electrons in electron-lens cathode-ray tubes. The other papers dealt with two main subjects, namely, questions of capillarity and of elastic semi-liquids. In the first group M. Ram (Ministry of Agriculture) considered the influence of a capillary film in the soil upon building foundations, while N. Klein (Rheological Laboratory of the Hebrew Institute of Technology) discussed the oil distribution in paper under the influence of gravity. In the second group, papers were given as follows: Dr. A. Katchalsky (Weizmann Institute of Science) presented the modern theory of cross-linked polymer gels; Dr. E. Alexander (Hebrew University) reported upon experiments with a modification of the Gardner mobilometer by means of which the time of thixotropic regeneration can be determined; Prof. Reiner showed how a contravariant measure of strain parallel with the usual covariant measure could account for the centripetal-pump effect in elastic liquids; and Miss I. Braun (Rheological Laboratory of the Hebrew Institute of Technology) demonstrated the effect in rubber toluene solutions.

Radiotherapy and Cancer

THE work of the Medical Research Council's radiotherapeutic research unit on the experimental comparison between the effects of gamma-rays and X-rays is recorded in "Researches on the Radiotherapy of Oral Cancer" by Constance A. P. Wood and J. W. Boag (Medical Research Council Special Report Series, No. 267; pp. 148+30 plates; London: H.M. Stationery Office, 1950; 12*s*. 6*d*. net). By means of the disk contour-finder, described fully in this report and illustrated by means of photographs and drawings by P. Howard-Flanders, it is

now possible to estimate the dose given and also its distribution in two planes. The histological work on the response of malignant tumours to irradiation, carried out at the Strangeways Research Laboratory, Cambridge, by Dr. F. G. Spear and Dr. A. Glücksmann, is described by these authors in Part 2 of the report and illustrated with photomicrographs. Important conclusions of the report are that the wavelength of the radiation *per se* had no significant effect on the clinical results, that there was no evidence that cancer of the primary site yielded more readily to radiation than did cancer of the glands, and that increase in the proportion of differentiating cells distinguishes epitheliomata responding favourably to radiation from those that failed to respond. The section of the report dealing with the future of research in radiotherapy contains valuable observations on the comparative value of radium beam therapy, high-voltage X-ray therapy and therapy with electron and neutron beams. To this section, Dr. L. H. Gray contributes a valuable article on the use of radioactive isotopes.

Termites and Building in the Tropics

Among the recommendations of the Commonwealth Entomological Conference in 1948 was that a simple manual should be prepared, designed for the practical builder and dealing with the protection of buildings and building material from termites. The Building Research Station and the Forest Products Research Laboratory, both of the Department of Scientific and Industrial Research, were asked to undertake the preparation of such a manual, and as a result "The Protection of Buildings and Timber against Termites" has now been published (Forest Products Research Bulletin No. 24; pp. 41+9 plates; H.M. Stationery Office, 1950; 1*s*. 9*d*. net). It is written by W. D. MacGregor, formerly conservator of forests, Nigeria and Sierra Leone, in collaboration with R. C. Fisher, officer in charge of the Entomology Section of the Forest Products Research Laboratory, and should prove of great value to all architects and builders who are concerned in the erection of buildings in countries subject to termite attack. A simple account of the biology and ecological classification of termites is followed by detailed instructions on prevention and control. The greatest emphasis is placed on preventive methods: the use of resistant timbers (indigenous timbers reputed to be resistant to termite attack are listed in an appendix), the impregnation of non-resistant timbers with preservatives, methods of building construction, termite barriers and the like which will prevent access by termites, and notes on the maintenance of such protective structures. The economic losses sustained from the attacks of termites are enormous; the widespread adoption of the methods set out in this manual should go far towards preventing that serious wastage.

Aids to Science Teaching

On behalf of Unesco the Ministry of Education has issued another volume in the series "Inventories of Apparatus and Material for Teaching Science". The series has been designed particularly to aid educationists in war-damaged and under-developed countries and takes the form of reference manuals from which the essential equipment necessary to teach science at the various levels may be selected. The lists are based on material not in use in the more highly developed countries. Each manual gives details of the modern curriculum to which the equipment it lists is related. Teachers are therefore given guidance about the kind of course they could undertake and also what equipment would be needed for administrative and experimental purposes. The first volume dealt with the teaching of science in primary, secondary and vocational schools, and the present one with the universities. It covers the subjects of botany, chemistry, geology, physics and zoology and also includes appendixes concerned with common abbreviations and conversion factors used in science, as well as a short list of suppliers of scientific instruments. Copies of the Inventory may be obtained from H.M. Stationery Office, price 12*s*. 3*d*.

British Hat and Allied Felt Makers Research Association: Annual Report

The third annual report of the director of research of the British Hat and Allied Felt Makers Research Association, covering the year ended August 1950 (pp. 16; Manchester, 1951), records some progress in research, but at the same time directs attention to the fact that comparatively few firms seem to make regular use of the services the Association can offer in dealing with their day-to-day problems or in the provision of technical and scientific information. The fundamental research programme has continued largely on the same lines as in previous years. The particular groups of the keratin molecule which take part in the carrotting of fur have now been determined with some certainty, and evidence has been obtained on the mode of action between fur and mercuric nitrate/nitric acid carrotting solutions. From extensive measurements of the elastic and other properties of wool and fur felt, a scheme of quality assessment has been drawn up which not only gives a quantitative measure of the material properties but also provides a fibre factor which defines the condition of the individual fibres. This fibre factor can indicate differences in original raw materials or degradation or damage in processing. A study of the felting property of wool noils showed that, for any particular type and treatment of wool, there is a maximum degree of felting and that further treatment of the wool only results in a change in shape. On the technological side, methods of addition and the amounts of acid used in processing fur hoods have been reviewed, the damage to animal fibres in dyeing and other processes examined, and a survey of felting machinery begun.

St. Andrews University Chemical Society

The *Journal* of the St. Andrews University Chemical Society for April 1951 (1, No. 5) contains a number of interesting short papers and provides abundant evidence that the Society is in a flourishing state. D. M. Dunlop describes an Arabic manuscript on alchemy in the University Library, Prof. John Read lectures on historical chemistry as an instrument of culture, Prof. R. D. Haworth on cycloheptane derivatives, and Prof. D. H. Hey on aromatic substitution. Other papers deal with various aspects of chemistry by experts in the fields concerned. The officers of the Society have been fortunate in having available a gift of paper, and they have made good use of it in producing a very attractive record of the lectures given to the Society.

Maritime Meteorology: Conference in Genoa

The Geophysical Institute of the University of Genoa is organizing a meeting on maritime meteorology, to be held in Genoa during September 20–22.

at the same time as the Columbus Celebrations. The meeting will be concerned with the main meteorological problems relating to navigation, with particular reference to the Mediterranean, and the principal themes will be: the vertical distribution of humidity in the air over the sea and over coastlines; the genesis of fogs and visibility at sea; winds at sea and over the coast and their influence on wave motion; and other relationships between the physics of the atmosphere and the physics of the sea. All meteorologists and oceanographers are invited to participate. Further details can be obtained from the Istituto Geofisico e Geodetico dell' Università, via Balbi 5, Genoa.

University of Sheffield: Appointments

THE following appointments in the University of Sheffield have been announced: Dr. R. Wheeler Haines, to be senior lecturer in anatomy; G. C. Briggs and W. Johnson, to be lecturers in mechanical engineering; Dr. R. P. N. Jones and M. L. Meyer, to be lecturers in the Postgraduate School of Applied Mechanics.

University of Aberdeen

AT a graduation ceremony held in the University of Aberdeen on July 12, the degree of Ph.D. was conferred on the following for the theses mentioned: W. C. Bain ("The Propagation of Radio Waves of Very Low Frequency"); Miss M. I. Chalmers ("Protein Digestion and Metabolism in relation to Level of Nutrition"); T. L. Dodsworth ("An Investigation into the Feeding of Beef Cattle with particular reference to the Substitution of Grass Silage for Root Crops"); Miss G. M. Ellinger ("Studies of Factors affecting Bone Development in Rats and Chicks"); K. El Shazly ("Some Studies on Protein Metabolism in the Rumen"); O. C. Farquhar ("The Geology of the Arnage District: A Study of Polymetamorphism"); E. A. Fitzpatrick ("A Study of the Effect of the Nature of the Parent Material on the Development of the Soil Profile with Special Reference to an Area in North-East Scotland"); D. A. Jones ("The Production and Properties of Artificial Crystals"); J. D. Lawson ("Scale Models in Hydraulic Engineering"); F. H. C. Marriott ("The Analysis and Interpretation of Multiple Measurements"); P. A. Orkin ("Studies on Breathing and the Aspiratory Heart of Elasmobranchs"); W. Paul ("The Inter-action of Radiation and Matter"); E. A. D. White ("The Hydrothermal Crystallization of Lithium Aluminosilicates").

Institution of Electrical Engineers: Awards

THE Council of the Institution of Electrical Engineers has made the following award of premiums for papers read or accepted for publication during the session 1950–51. Group A: *Kelvin Premium:* B. Adkins; *John Hopkinson Premium:* R. J. Clayton, Dr. D. C. Espley, G. W. S. Griffith and J. M. C. Pinkham. Group B, Non-Section Premiums: *Llewellyn B. Atkinson Premium:* J. H. Mason; *Extra Premium:* H. F. Church; Measurements Section Premiums: *Silvanus Thompson Premium:* Dr. A. H. M. Arnold; *Mather Premium:* J. G. Yates, D. H. Lucas and D. L. Johnston; *Extra Premiums:* E. H. Cooke-Yarborough and E. W. Pulsford; H. H. Rosenbrock and J. R. Tagg; Dr. D. Taylor, J. Sharpe and W. Abson; Humphry M. Smith; J. R. Boundy and S. A. Bergen; O. I. Butler; Radio Section Premiums: *Duddell Premium:* P. A. T. Bevan and H. Page; *Ambrose Fleming Premium:* Dr. J. A. Saxton, G. W. Luscombe and G. H. Bazzard *Extra Premiums:* E. A. Nind and E. McP. Leyton Caradoc Williams; Dr. L. Essen; W. S. Melville R. W. Douglas and Dr. E. G. James; H. B. Rantzen, F. A. Peachey and C. Gunn-Russell; D. G. Kiely, Instr. Lieut. A. E. Collins and G. S. Evans; Dr. A. W. Lines, G. R. Nicoll and Mrs. A. M. Woodward; Supply Section Premiums: *Sebastian de Ferranti Premium:* H. Leyburn and C. H. W. Lackey; *John Snell Premium:* T. F. Monahan; *Extra Premium:* A. C. H. Frost and W. Brittlebank; Utilization Section Premiums: *Crompton Premium:* M. J. J. Cronin; *Swan Premium:* W. D. Chesterman, D. R. Glegg, G. T. Peck and A. J. Meadowcroft; *Extra Premium:* T. H. Petch. Group C: *Heaviside Premium:* Dr. G. G. Macfarlane and Mrs. A. M. Woodward; *Paris Exhibition* (1881) *Premium:* D. B. Hogg; *Oversea Premium for Students and Graduates:* G. W. Donaldson; *Students' Premiums:* C. R. Bates; R. W. Gee; K. F. Tee; J. C. Shaw; P. D. Aylett; B. Berger; D. Bolton; E. J. R. Hardy; I. J. Shelley; D. S. Williams.

Announcements

THE Alvarenga Prize for 1951 of the College of Physicians of Philadelphia has been awarded to Dr. George W. Thorn, Hersey professor of the theory and practice of physic, Harvard University Medical School, for his outstanding contributions to our knowledge of the role of the adrenal cortex in health and disease.

SCIENTIFIC Report Series No. 13, "The Structure and Configuration of Sucrose", published by Sugar Research Foundation, Inc., New York (pp. 40; June 1950; free), contains an interesting historical review of the subject, with full references to literature. The text is by Dr. I. Levi and Prof. C. B. Purves.

BRITISH Standards Specifications Nos. 628–32 and 650–56 (1950) on vegetable oils, and 684 (1950) on methods of analysis of oils and fats, give the specifications of several vegetable oils, and standard methods of analysis of these, respectively. The first costs 6*s.* net and the other two 7*s.* 6*d.* net, in each case postage paid, obtainable from the British Standards Institution, Sales Department, 24 Victoria Street, London, S.W.1.

A SYMPOSIUM entitled "Chemical Shortages and the Efficient Use of Processing Solutions" has been arranged by the Scientific and Technical Group of the Royal Photographic Society, in collaboration with the British Kinematograph Society, and will be held on October 3 at Film House, Wardour Street, W.1, starting at 7.15 p.m. Particulars can be obtained from the honorary secretary of the Group (Mr. D. H. O. John, c/o May and Baker, Ltd., Dagenham, Essex).

No. 9 of the Reader's Guides, New Series, published by the County Libraries Section of the Library Association (Chaucer House, Malet Place, London, W.C.1), deals with "Chemical Technology" and can be obtained from the Publications Secretary of the County Libraries Section of the Library Association, County Library, County Hall, Trent Bridge, Nottingham (price 4*d.*), or free of charge through county or municipal libraries. This guide contains a classified list of books dealing with various aspects of chemical technology, including prices, which should be very useful to librarians of research institutions, college and school librarians, and others, as well as to public library officials.

TRANSAMINATION TO PYRUVATE AND SOME OTHER α-KETO-ACIDS

By E. V. ROWSELL
Biochemical Laboratory, University of Cambridge

UNTIL recently, it had become accepted that biological transamination was confined in its scope to the reactions: L-alanine + α-ketoglutarate ⇌ L-glutamate + pyruvate and L-aspartate + α-ketoglutarate ⇌ L-glutamate + oxalacetate.

It is now clear that in numerous organisms and tissues, enzymes exist catalysing the transfer of the α-amino groups of many other L-α-amino-acids to α-ketoglutarate to produce L-glutamate, and from L-glutamate to various α-keto-acids to produce their corresponding amino-acids[1-3]. Hitherto, however, experimen ; have indicated that either α-ketoglutarate or L-glutamate must be involved as one of the substrates in biological transamination reactions.

Experiments with insoluble particle preparations of rat-liver homogenates show that they are able to catalyse a direct transfer of the α-amino group from various L-α-amino-acids to pyruvate, to give alanine. Rat liver obtained from the animal immediately after death was homogenized in cold *M*/10 phosphate *p*H 7·8, and the insoluble particles of the homogenate washed several times by spinning down from resuspension in the buffer, on the high-speed head of the cold centrifuge. The washed particles obtained from a rat liver weighing about 9 gm. were finally taken up to a volume of 15 ml. in phosphate buffer, *M*/10, *p*H 7·8. Incubations were carried out in test-tubes with the amino-acid under test at a final concentration of 0·03 *M*, and pyruvate 0·02 *M*, in a total volume of 2 ml., including 1 ml. of the particle preparation. The incubations took place anaerobically under an atmosphere of nitrogen, at 37° C., and usually for one hour's duration. The reactions were stopped by immersing the test-tubes in boiling water for three minutes, after which the denatured protein was spun down and the supernatants investigated by paper chromatography.

In order to reduce the time involved in the chromatographic investigations, a simple technique has been employed. Sheets of filter paper (7 in. × 4 in.), near the bottom edge of which the samples for amino-acid analysis had been spotted, were held between glass rods, and thus suspended from a glass tripod standing inside a desiccator which contained a thin layer of the chromatographic solvent. Within two or three hours the ascending boundary travelled far enough to separate the two amino-acids concerned, with the appropriate choice of solvents and filter paper. Phenol saturated with water, and propanol–water (4 : 1) have been mostly used. In order to avoid streaking of the spots, which otherwise occurs with phenol in these short runs, a stock of papers was maintained equilibrated in an atmosphere of phenol and water vapour. This technique also effects considerable economy in the consumption of chromatographic solvents, though it is obviously limited to investigations involving only one or two amino-acids.

Amino-acids which will transfer their amino-groups to pyruvate to give alanine, when incubated with these preparations, are L-leucine, L-phenylalanine, L-methionine, L-histidine and L-tyrosine. Control experiments in which pyruvate alone, and each amino-acid alone, were incubated with the washed particle preparations, gave no observable formation of alanine. Other control experiments were carried out with buffer substituted for the tissue preparation, and also with boiled tissue preparations; but in no case was there any non-enzymic formation of alanine. Similar controls have been carried out with negative results in all the experiments described below. Amino-acids which have been shown not to take part in this transamination to pyruvate are L-valine, L-aspartate, glycine and L-tryptophane, though the washed particles will catalyse transaminations between all the amino-acids mentioned, including these, and α-ketoglutarate.

No glutamate was observable on the chromatograms of these experiments and none was detectable in the homogenates, on testing manometrically with glutamic decarboxylase (washed suspensions of *C. welchii SR*12). It was nevertheless thought desirable to test the possibility that alanine might be produced by a coupling of two reactions, for example, L-leucine + α-ketoglutarate → L-glutamate + α-keto*iso*caproate, followed by pyruvate + L-glutamate → L-alanine + α-ketoglutarate, the whole process being catalysed by a trace amount of L-glutamate or α-ketoglutarate firmly adsorbed on the particles. If this were the mechanism of alanine production, one would expect that L-aspartate, more readily than any other amino-acid (with the exception of L-glutamate), would form alanine on incubation with pyruvate, since the rate of transamination to α-ketoglutarate is higher from L-aspartate than from any other L-α-amino-acid. However, although chromatograms showed that the particle preparations would catalyse an abundant synthesis of glutamate from L-aspartate and α-ketoglutarate, and of alanine from L-glutamate and pyruvate, no direct reaction of L-aspartate with pyruvate to give alanine was observed. Moreover, no aspartate was observed to have been formed when L-leucine and L-methionine were incubated with oxalacetate, which would be expected if L-glutamate

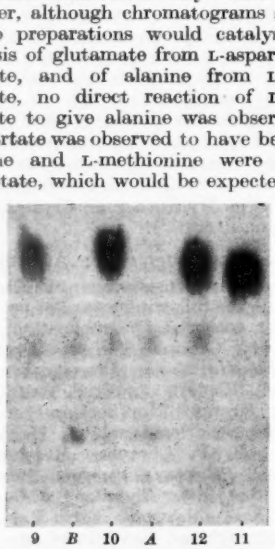

Fig. 1. Short-run chromatogram showing the formation of alanine from phenylalanine (9), leucine (10), and methionine (12), incubated with pyruvate in the presence of washed rat liver particles. None formed from valine and pyruvate (11). Markers containing 0·3 mgm./2 ml. (*A*), and 0·5 mgm./2 ml. (*B*), of both alanine and glutamate, run on the same paper for comparison. Water-saturated phenol on Whatman No. 1 paper

were acting as an intermediate carrier in the formation of alanine from pyruvate. It must be concluded that in the experiments described above there was direct transamination between the amino-acids used and pyruvate.

The supernatants of rat-liver homogenates from the first spinning have been clarified of all visible particles by repeated high-speed spinning and filtration. After prolonged dialysis they have been shown to be effective in catalysing the transamination to pyruvate from those amino-acids which are effective with the washed-particle preparations. These clear supernatant preparations will not catalyse transamination to α-ketoglutarate from L-leucine, L-phenylalanine, L-methionine, or L-valine, and thus constitute an obvious starting point for the purification of the pyruvate transaminase enzyme or enzymes.

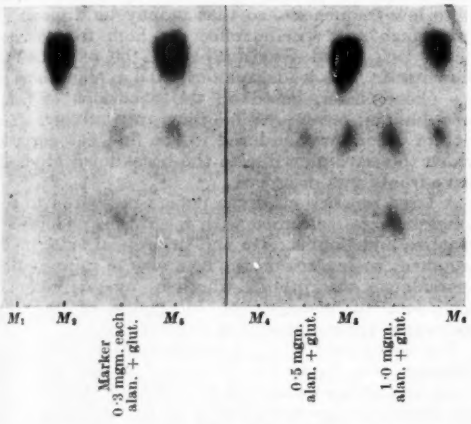

Fig. 2. Short-run chromatograms showing results with washed mouse liver particles. M_1, α-ketoglutarate alone. M_2, L-leucine + α-ketoglutarate. M_4, pyruvate alone. M_5, L-leucine + pyruvate. M_6, L-phenylalanine + pyruvate. Markers containing 0·3 mgm., 0·5 mgm. and 1·0 mgm. of both alanine and glutamate in 2·0 ml. Water-saturated phenol on Whatman No. 1 paper

The hypothesis that L-α-amino-acids are oxidized by the indirect process of transamination to α-ketoglutarate, followed by the oxidation of the L-glutamate thus produced, has been considered. Model experiments using tissue preparations and involving this sequence of reactions have been carried out by Braunstein and his co-workers[4]. The possibility that the oxidation of some L-α-amino-acids in some tissues takes place by the complicated route of transamination to pyruvate, followed by transamination

Fig. 3. Short-run chromatogram showing results of incubations with rat liver clarified supernatant. The substrates were α-keto-n-butyrate in each case, with buffer as control (*O*), L-phenylalanine (*P*), L-leucine (*Q*), L-methionine (*R*), and L-alanine (5). Propanol–water (4 : 1), on Whatman No. 1 paper

from L-alanine to α-ketoglutarate, and this followed by the co-enzyme I – linked oxidation of L-glutamate, is one that must be considered.

In some cases, both with washed-particle preparations and with supernatant preparations, experiments have been conducted in Warburg manometers, containing potassium hydroxide in the centre tube, to find out to what extent L-α-amino-acids are directly oxidized by atmospheric oxygen in these preparations. Washed-particle preparations which gave a synthesis of about 0·5 mgm. of alanine in one hour, under the conditions described above, from pyruvate with L-leucine, L-phenylalanine, and L-methionine, catalysed no oxygen uptake above that of the no-substrate control. Phosphate buffer replaced pyruvate to make up the volume for the manometric experiments. Fig. 1 shows the formation of alanine from L-phenylalanine, L-leucine and L-methionine after their incubation for 45 min. with pyruvate, and may be compared with the following figures for oxygen uptake obtained manometrically over the same period, using the same washed particle preparation :

Water control	11 μlit.
L-leucine	9 ,,
L-phenylalanine	8·5 ,,
L-methionine	8·5 ,,

Clarified supernatant preparations were no more effective in catalysing the direct aerobic oxidation of L-α-amino-acids.

	Pyruvate as amino-acceptor leading to formation of alanine with :				α-Ketoglutarate as amino-acceptor leading to formation of glutamate with :			
	L-leucine	L-phenyl-alanine	DL-meth-ionine	L-valine	L-leucine	L-phenyl-alanine	DL-meth-ionine	L-valine
Mouse-liver washed particles (Fig. 2)	+	+			−	−		
Whole dialysed pigeon-liver homogenate	+	+			+	+		
Pig-liver washed particles	−	−	−	−	+	+	+	+
Pig-liver dialysed supernatant	−	−	−	−				
Chicken-liver washed particles	−	−	−	−	+	+	+	+
Rat-kidney washed particles	−	−	−	−	+	+	+	+
Rat-kidney dialysed supernatant	−	−	−	−				

The reversal of the transamination to pyruvate has also been demonstrated. Incubation of washed rat-liver particles with L-alanine and α-keto-*n*-butyrate led to the formation of α-amino-*n*-butyric acid, while with α-keto*iso*caproate they gave leucine, and with phenylpyruvate they gave phenylalanine. (In these experiments the final concentration of L-alanine was 0·03 *M*; that of the keto-acid was 0·025 *M*. The incubation conditions and subsequent operations were the same in these experiments, and in all the experiments to be described, as those detailed above.) These syntheses were not effected when D-alanine or L-aspartate was substituted for L-alanine.

Other animal tissue preparations that have been examined, using the same experimental techniques, for transamination to pyruvate and α-ketoglutarate, are listed in the accompanying table; + denotes their ability, − their inability, to catalyse transamination with the substrates indicated. The whole range of amino-acids tested with each preparation is noted; it may be that other amino-acids would behave differently.

Experiments with dialysed supernatants of rat-liver homogenates show that they are able to catalyse transamination from L-phenylalanine, L-methionine and L-leucine, directly to α-keto-*n*-butyrate to produce α-amino-*n*-butyric acid (Fig. 3), from L-leucine to phenylpyruvate to give phenylalanine, and from L-phenylalanine to α-keto*iso*caproate to give leucine. In these experiments the L-amino-acids were at a final concentration of 0·03 *M* and the α-keto acids 0·025 *M*. (Sodium α-keto*iso*caproate and α-keto-*n*-butyrate were kindly provided by Dr. A. Meister.)

It is evident that biological transamination includes in its scope a much wider range of α-keto-acid acceptors than has hitherto been recognized. It is also obvious, even from the application of this qualitative method for the analysis of amino-acids, that big differences exist between different animal species and tissues in their transaminating ability. Many potential amino-group donors and keto-acid acceptors, including peptides and ketopeptides, will need to be investigated for their interaction in a wide range of organisms and tissues before the full scope of the transamination reaction can be appreciated.

I wish to thank Dr. D. M. Needham and Dr. F. J. R. Hird for their advice and encouragement during the course of this work, and to acknowledge a grant from the Medical Research Council.

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ULTRASONICS IN FLUIDS

UNDER the auspices of the Royal Flemish Academy and the United Nations Educational, Scientific and Cultural Organization, an international conference on ultrasonics was held in Brussels during June 7–9 under the presidency of Prof. A. van Itterbeek; the secretary was Prof. A. J. Rutgers. There were about one hundred participants representing most countries of Western Europe, the United States of America and Australia. It may indeed seem that workers in ultrasonics are insatiable in discussing their activities, since this congress followed so closely on the heels of those of Erlangen (1949) and Rome (1950); but the earlier meetings dealt rather with applications of ultrasonics, whereas this year's meeting was concerned entirely with physical measurements and theories.

The subjects proposed for discussion were the following: (*a*) absorption and dispersion in gases and in pure liquids; developments in the field of 'second viscosity of liquids'; (*b*) absorption in electrolytic solutions; relaxation time for ionic interactions; ultrasonic vibration potentials in colloidal solutions; (*c*) absorption in liquid mixtures or in liquids containing solid particles or gas bubbles; (*d*) absorption in liquid helium; 'second sound'.

On the first morning, a lively discussion soon developed on the significance of the 'streaming' of fluid from the surface of an ultrasonic emitter contained in a tube, and the vortices so set up, from the point of view of the dilatational viscosity which Stokes invoked only to ignore. It was pointed out that similar circulations can be set up in a liquid at quite low frequencies, so that it may be difficult to distinguish any specific effect at high frequencies, when the 'second viscosity' would be expected to show itself. This leads to alternative explanations of the phenomenon, based on the equations of compressible and incompressible flow, respectively. Yet a third theory was adduced in the first category, in which the streaming due to the breakdown of shock wave-fronts was discussed.

A large proportion of the papers presented to the congress were concerned with relaxation phenomena in gases and liquids. On the theoretical side, much argument took place on the best way of representing anomalous absorption, whether by a complex coefficient of viscosity or by single or multiple relaxation times, usually of thermal type.

For water near 4° C., a configurational relaxation between two types of structure having different compressibilities seems best to represent the observed absorption/temperature curve. In applying these theories to actual fluids, with the possible exception of hydrogen, some data have to be taken from the experimental results and it is well, as one speaker reminded us, that we should be clear in our own minds when we are doing this.

On the experimental side, new results were presented for velocity and absorption in organic liquids and mixtures thereof, electrolyte solutions, liquid hydrogen and liquid helium. Besides the common variable-path interferometers and pulse techniques, some data were presented from measurements with the radiation pressure, probe microphone, hot-wire, reverberation and *Schlieren* methods. Interesting reports were also presented of experiments on scattering by solids or liquid bodies surrounded by other liquids, and of the setting-up of potential fields in colloids under the action of ultrasonics.

Measurements of ultrasonic absorption in the critical regions between gas and liquid on one hand and between solid and liquid on the other have recently been made. Glycerine in the neighbourhood of −10° C. exhibits the latter transition, showing a maximum of absorption to 30 Mc./sec. waves at this temperature. Some theories relating to relaxation in this quasi-solid state were advanced, though it is interesting to note that the existence of relaxation frequencies in solids was first discussed by Prandtl for the sonic range in 1928. The ultrasonic relaxations for liquids discovered later bear a close resemblance, in a different part of the gamut, to these.

The final morning was devoted to the propagation of sound in liquid helium II, wherein both acoustic

and thermal waves ('first' and 'second' sound) may be propagated. The interactions of these two types and the effect of a temperature boundary-layer which forms at the walls of the containing vessel were discussed from the theoretical point of view by a number of speakers, while experiments were adduced relating to the discontinuity in velocity of 'first' sound at the lambda-point and the theoretical relation which would make this velocity equal to three times the velocity of 'second' sound as absolute zero is approached.

The papers (about thirty-five in all) presented to the conference will eventually be published (in English, French or German) in the *Mededelingen Koninklijke Vlaamsche Academie voor Wetenschappen* (Brussels). It is hoped that summaries of many of the papers will appear in a forthcoming number of the journal *Acustica*.

E. G. RICHARDSON

CATION EXCHANGE AND CLAY MINERAL STRUCTURE

A MEETING of the Clay Minerals Group of the Mineralogical Society, held at Rothamsted Experimental Station, Harpenden, during April 27–28, was largely devoted to a discussion on cation exchange and clay mineral structure, although some general papers were also read and discussed. On the evening of April 27 a lecture on the development of the fuller's earth industry, and the uses of fuller's earth from earliest times, was delivered by R. H. S. Robertson (Glasgow).

The discussion on cation exchange and clay mineral structure was introduced by Dr. D. M. C. MacEwan (Rothamsted), who, with the aid of models, outlined the structures proposed for montmorillonite by Hofmann, Endell and Wilm[1], and by Edelman and Favejee[2], and pointed out that this discussion was, in effect, an attempt to see how far the available data could help towards a decision as to the most probable structure.

Prof. H. Deuel (Zurich) described the preparation and properties of organo-silicon compounds, especially the silanols containing Si—OH groups, and pointed out that Edelman and Favejee have postulated such groups in clay minerals. The previous work of Berger[3], and others, has shown that clays can give organic derivatives, and Prof. Deuel himself has prepared a considerable range of such compounds using 1,2-epoxides, mustard gas, etc. Thionyl chloride gives extremely reactive clay chlorides, which react with, for example, alcohol to give esters, etc. The decrease in cation-exchange capacity after esterification corresponds exactly to the amount of ester groups introduced, and the original cation-exchange capacity returns on hydrolysis. Similar esters prepared from different clay minerals have different properties, an observation which may lead to the development of a method for separation of minerals. In the discussion, H. R. Samson (Rothamsted) suggested that the reactions might be due partly to the hydroxyl groups of decomposition products formed by reaction of the clay with drastic reagents such as thionyl chloride, or of $Al(OH)^{++}$, present in the hydrogen-montmorillonite. Dr. B. S. Neumann (Fuller's Earth Union, Ltd.) inquired whether free silica gel in the samples might not cause such reactions.

Recent attempts to distinguish between the two structures were described by M. J. Méring (Paris), who pointed out that, on the Hofmann–Endell–Wilm theory, structural water should amount to 5·1 per cent, while on the Edelman–Favejee one it should be 6·1 per cent. With normal analytical methods, it is difficult to distinguish between the final removal of sorbed moisture and the beginning of removal of structural water. However, Mlle. Glaeser's use of the Fischer reagent for determination of sorbed water seems promising. Surface areas of calcium- and sodium-montmorillonites with varying water contents and X-ray data for calcium-sodium-montmorillonites, etc., have also been examined. The results tend to favour the Hofmann–Endell–Wilm structure rather than the Edelman–Favejee one. In the discussion, P. Franzen (Amsterdam) suggested that application of the methods of M. Méring to the compounds of Prof. Deuel may lead to considerable further information.

The observation that lithium-montmorillonite loses water irreversibly at a much lower temperature (about 150° C.) than montmorillonite saturated with other cations was discussed by R. Greene-Kelly (Rothamsted). Méring's suggestion that the formation of O—Ca—O bonds[4] between the sheets in calcium-montmorillonite causes the sheets to be locked in position and therefore irreversibly dehydrated can scarcely hold for Li^+, although it might be that Li^+ would react with one of the hydroxyl groups. Attention was directed to other peculiarities of lithium-montmorillonite[5] and lithium-vermiculite[6], in the ensuing discussion, by Dr. R. C. Mackenzie and Miss A. A. Milne (both of Aberdeen). M. Méring stated that he has now abandoned the O—Ca—O hypothesis, while Prof. Deuel suggested that Si—O—Si links might be formed by condensation of two Si—OH groups in separate layers. He also suggested the study of irreversible dehydration in hydrogen-montmorillonite; but several speakers doubted the existence of this material.

Prof. D. McConnell (Ohio) communicated a paper on the calculation of the structural formula of montmorillonite, assuming three cations (silicon, hydrogen and aluminium) present in the tetrahedral layer, that is, partial substitution of $(OH)_4$ for SiO_4[7]. Some doubt was cast on the existence of tetrahedral hydroxyl groups by R. Greene-Kelly, who showed some thermograms for one sample of montmorillonite saturated with various cations, where the relative sizes of the two high-temperature endothermic peaks vary with the exchangeable cation. K. Norrish (Rothamsted) mentioned that Hendricks has suggested that the final endothermic peak may be due to isolated hydroxyl groups unable to condense until the final recrystallization takes place—a suggestion supported by Dr. S. J. Gregg (Exeter), who pointed out the difficulty in removing the last traces of a gas in many decompositions, for example, calcium carbonate, magnesium carbonate, etc. The possibility that hydroxyl groups in McConnell's structure would be partially dissociated and give rise to cation-exchange was suggested by Prof. Deuel.

Experiments on the effect of grinding on micas, described by Miss Milne and Dr. Mackenzie, showed that the cation-exchange capacity of muscovite increases to about 130 m.equiv./100 gm. after nine hours of grinding, remains constant at this value for about another nine hours and then tends to increase again. Corresponding changes observed in the X-ray data indicate almost complete breakdown of the structure by nine hours, with gradual recrystallization into illite thereafter. The cation-exchange capacity

of biotite increases with grinding for twenty-four hours, and the lines in the X-ray patterns tend to become diffuse; peculiarities observed with vermiculite cannot yet be explained. In the discussion, R. W. Nurse (Building Research Station) pointed out the severe nature of dry grinding, while Dr. Gregg and Dr. G. W. Brindley (Leeds) both described work on the grinding of kaolinite and halloysite.

In the section devoted to general papers there were three contributions from Rothamsted., The technique employed there by H. L. Nixon and Dr. A. Muir for obtaining electron micrographs of clays was described and a number of excellent electron micrographs shown. In reply to Dr. G. Nagelschmidt (Sheffield), Dr. Muir confirmed that the hexagonal crystals in some of the micrographs are metahalloysite, this having been checked by X-rays. The theory of X-ray diffraction and absorption by oriented flakes and rolled specimens was discussed by K. Norrish and Dr. MacEwan. Equations giving the angular distribution of any particular crystal plane in terms of the distribution of particles have been derived, and the effect of orientation and flake shape on intensities calculated. The calculations give a method of determining the distribution of particles from the variation of intensity of a particular line at different settings of the specimen. Dr. Nagelschmidt and Dr. Brindley both stressed the importance of this theory in quantitative analysis and in structure determinations, and Dr. Brindley explained that, in certain cases, the distribution of particles is obtainable from one photograph. In the third paper, Dr. MacEwan presented a detailed table in which clay mineral types are classified on structural grounds[8]. Use is made chiefly of an extension of the significance of existing names; for example, there are three groups, depending on the number of O, OH layers in the structure, and these are divided into thirty-three sub-divisions through the major divisions: kaolinoids (or kaolin minerals), micas, montmorillonoids, vermiculites and chlorites. This classification was compared with other attempted classifications. In the discussion, Dr. Brindley spoke of the necessity of consideration of such schemes in reaching any definite ruling on nomenclature.

Adsorption isotherms of carbon tetrachloride, water and oxygen, as well as density in carbon tetrachloride, have been used by Dr. Marjorie J. Brown (Exeter) and Dr. Gregg to investigate changes induced in kaolinite on heating. In the region where the water-loss becomes largely irreversible (400–490° C.), the morphology of the grains cannot be greatly changed, since the surface area increases only slightly. A slight decrease in area is observed at about 720° C.; but even at 1,000° C. both area and sorption are still appreciable. H. R. Samson gave some optical evidence supporting the small area change in the 400–500° C. region. Dr. Brown, in reply to Dr. G. Nagelschmidt, indicated that this work is to be extended to montmorillonites saturated with various cations.

Although cold-precipitated hydrated ferric oxide appears to be widespread in soils and clays[9], the conditions necessary for its formation have not yet been determined. The conditions under which it can be formed and is stable in the laboratory were described by Dr. Mackenzie. The changes occurring in the mineral with changes in the mode of preparation have been studied by X-ray, electron diffraction and other methods, and some suggestions were made as to possible modes of origin in Nature. Dr. Neumann reported that similar changes can be obtained with hydrated aluminium oxides, the *endothermic* peak temperature increasing as the precipitation temperature is raised.

The discussion both on the special subject and on the general papers was very valuable and stimulating, but it was obvious that at present no definite agreement as to the correctness of either the Hofmann–Endell–Wilm or the Edelman–Favejee structure can be arrived at. Prof. McConnell's hypothesis has attractive features as a compromise; but at present it is apparently open to some objections, and only if these are overcome can it be accepted.

R. C. MACKENZIE

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NEW DEVELOPMENTS IN VISCOMETRY

COLLOQUIUM AT BIRMINGHAM

A COLLOQUIUM on "New Developments in Viscometry" was held by the British Society of Rheology on May 11 in the Department of Chemical Engineering, University of Birmingham. The discussion was introduced with a paper by Dr. R. S. Higginbotham (Shirley Institute, Manchester) and J. J. Benbow (Dunlop, Ltd.) entitled "Some Novel Viscometers for Rapid Measurements under Defined Conditions". Dr. Higginbotham spoke at first on the historical development of rotatory viscometers, including the cone and plate types, mentioning their limitations and discussing procedures for obtaining rheological constants of starch pastes, thick suspensions and soft solids in general over a wide range of shearing stress. A precise knowledge of these constants, including the extent of changes due to thixotropy and dilatancy, is of great importance in selecting and controlling the manufacture of materials in textile printing. Electrical viscometers of the cone and plate types, robust in design and of simple operation, have been designed and found useful for control purposes.

Dr. P. S. Williams (Paints Division, Imperial Chemical Industries, Ltd.) described a new design of co-axial cylinder viscometer with the torsion wire replaced by a strain-gauge assembly holding the inner cylinder. Intended for research purposes with high-concentration suspensions, it has been built to a simple and robust design with a self-centring journal bearing. Results obtained with fine suspensions and gels of silica spheres were discussed with reference to thixotropic changes after different periods of shearing.

Dr. G. F. Eveson and G. H. Higginbotham, of Prof. S. G. Ward's laboratory, Mining Department, Birmingham, discussed results obtained with fine dispersions of spheres in a lead acetate–glycerol medium using different kinds of viscometers, with special reference to the sigma phenomenon which appears to be absent when some types of viscometers

are used, due presumably to the kind of flow prevailing. Experiments have been carried out using different gaps between rotating cylinders, allowing for a wide range in the ratio of particle size to length of annular gap. Similar results for slip at the cylinder walls have been obtained under the various conditions. Special research viscometers for dealing with settling suspensions and methods of analysing the results obtained were next described. Following further discussion by the meeting, under the chairmanship of S. F. Freeman (Mars, Ltd.), of proposed new viscometers, visits were made to the laboratories of the University where rheological work was proceeding.

E. W. J. MARDLES

UNIVERSITIES' FEDERATION FOR ANIMAL WELFARE

SILVER JUBILEE

By PROF. A. N. WORDEN

THE British Science Guild, which derived from the British Association for the Advancement of Science, was formed for the purpose of promoting the application of scientific methods and results to public affairs. In 1926 its honorary secretary was C. W. Hume and its most active member Sir Richard Gregory, then editor of *Nature*. The Guild has since been re-absorbed into the British Association; but one of its unofficial offspring, the University of London Animal Welfare Society, or ULAWS (now expanded into the Universities' Federation for Animal Welfare, or UFAW) is still very much alive and has recently celebrated its jubilee by a dinner held in London. It was Major Hume's thesis that the right relations between man and his fellow creatures were a proper study for the attention of university people as such. His first aim in founding the University of London Animal Welfare Society was to secure the support of veterinarians and zoologists; but the veterinary profession was at that time largely at variance with animal welfare movements. A contemporary vivisection controversy found the Society attacked by the anti-vivisection societies and suspected by experimentalists of harbouring in its ranks those of the category since dubbed 'crypto-antivivs'.

Major Hume's refusal to bow before these attacks, or to be discouraged by the initial apathy of the majority of those whose support he solicited, was steadfast. By 1939 hundreds of members and thousands of subscribers had been enrolled, funds from legacies and broadcast appeals had accrued, and the movement had been extended to other universities. In the same year it was decided that the now extensive educational efforts should be backed by original work, and a Scientific Investigations Committee was accordingly formed. Small grants were made for work on rabbit ecology, at the Bureau of Animal Population, Oxford, and for some studies on euthanasia in dogs in the Department of Pharmacology at the same University.

War, the early demise of the Federation's secretary and the destruction of its offices by enemy action naturally hampered many projects. On one enterprise, however, work was continued, and by 1943 it was possible to begin the preparation for publication of a standard text-book upon the care and management of laboratory animals. The support of research workers for such a work was world-wide. Literally hundreds of scientific workers offered their support and the subsequent book, published some four years later, obviously filled a very real need. Only the anti-vivisectionist Press failed to accord it a most favourable reception.

Shortly after the conclusion of hostilities, the Federation made a substantial grant for research on rabbit ecology and control by the Department of Animal Health, University College of Wales, Aberystwyth. It had long been felt that trapping, while a barbarous procedure, was probably an unsound practice from the agricultural point of view, but scientific proof was wanting. These studies continued for more than four years, and attracted the interest and collaboration of official bodies. One of the county agricultural executive committees initiated a widespread attempt at rabbit control based upon methods investigated by the workers in the Department of Animal Health. The reports of the extensive investigations upon control measures, and upon the damage to pastures inflicted by rabbits, are at present being prepared for full publication. The information available by 1950 was placed before the Home Office Committee on Cruelty to Wild Animals. It is evident from its report (Cmd. 8266) that the Committee was duly impressed by the evidence given. The objective presentation to a departmental committee by an animal welfare organization of factual scientific material must have been something of a novelty; but it is, of course, this very combination of humanitarian outlook and scientific approach that characterizes the Universities' Federation for Animal Welfare and places it in the category of a scientific society.

Substantial support has more recently been given to investigations relating to the electrocution and electro-anæsthesia of animals. At present these studies are being undertaken by a veterinary physiologist attached to the Neuropsychiatric Research Centre, Whitchurch Hospital, Cardiff, in the hope of yielding much-needed information on the painlessness or otherwise of electrocution and electro-stunning apparatus now in use, and upon the future possibilities of electroplectic anæsthesia.

Yet another problem supported by the Federation is that of the humane destruction of whales. Here much of practical value has already been achieved in work undertaken at sea by one of the British whaling companies, but the full results are not yet available for study.

These original investigations, while forming a heavy burden upon the slender funds of any charitable organization, have not been pursued to the detriment of educational work at home or abroad. The *UFAW Courier* is widely read, and a great deal of lecturing is carried out by members of the staff and by co-operating men of science. Before the War, membership was extended so as to include not only university men and women but also those members of the learned professions who were not university graduates.

From the first twenty-five years there is therefore much of which the Federation has cause to be proud. Its officials feel, however, that it is still extremely young. They note with satisfaction the birth of kindred ideas elsewhere. The recent formation in the United States of an Animal Care Panel, by veterinarians and scientific workers engaged in animal

experimentation, is one such example. From its "temporary war-time address" (284 Regent's Park Road, Finchley, London, N.3) the Federation has built up extensive relationships that bode well for the future treatment of animals. There is no shortage of problems, and even though in some veterinary and laboratory circles there still remains a suspicion of anything termed 'animal welfare', this prejudice will finally be broken down by further deeds. In respect of the laboratory world alone, it is fair comment that the Federation's activities have tended to aid both the well-being of the animals themselves (which is largely a husbandry problem) and the value of them for experimental purposes. The Federation is concerned not with the sterile argument of whether experiments on living animals are justified, but with the best conditions in which laboratory animals may be maintained. Dr. E. C. Morland, formerly editor of the *Lancet*, wrote to Major Hume after the publication of the "Handbook" to congratulate the Federation for ". . . mediating with rare insight between two irreconcilable combatants. It relieved my mind of the misery of watching it go on, year in and year out and, it seemed for ever. Accept the thanks of one who knows.

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

ANNUAL REPORT FOR 1949–50

THE outstanding feature of the forty-ninth annual report of the Carnegie Trust for the Universities of Scotland*, which covers the academic year 1949–50, is the increased expenditure on research schemes, the total of £34,088 being the largest thus far required in the history of the Trust for postgraduate study and research. From surpluses at its disposal from the eighth quinquennial distribution to the universities and colleges, the Committee made extra grants of £13,000 each to St. Andrews and Aberdeen, and £20,000 each to Glasgow and Edinburgh. From the beginning of the year under review, the value of the research scholarships was raised from £250 to £300, the senior scholarships from £400 to £450, and the fellowships from £700 to £800 with a possible further £50 for exceptional expenses. Expenditure on these awards now exceeds £12,000 a year, and the Committee proposes in future to invite nominators to these scholarships to say privately whether a trial year in the first place is desirable. During this trial the scholarship would be £200 and would be tenable at the parent university under close supervision of the nominator or other member of the university department in which the scholar proposes to work.

Block grants to the four Universities for research at home or abroad by members of staff have been extended, from October 1950, by a tentative scheme to involve not more than fifteen specially selected members of the university staffs in each year who will be given leave of absence for three to twelve months to prosecute lines of research on which they have already made such progress that conference with workers in the same fields in other countries is highly desirable. Six of these awards each year will be for travel to, and maintenance in, the United States. The Committee is also continuing, particularly in co-operation with the publications committees of the universities, its system of guaranteeing against loss books which are the fruit of sustained research on the part of their authors, but which are of a nature likely to have only a limited public. Further assistance has also been given to learned societies in Scotland in the publication of their transactions and journals, as well as, through the universities, to the Third Statistical Account.

Awards of fellowships, scholarships and grants for 1950–51 are detailed in the report, which also includes, besides reports on the work of investigators under the research scheme during the year 1949–50 and from the superintendent of the laboratory of the Royal College of Physicians, lists of publications by fellows, scholars and recipients of grants and of assisted papers, together with details of assistance to students and an abstract of accounts for 1949–50. Assistance to students has been confined to those who, for adequate reasons, had no bursary from a local education authority or whose circumstances and exceptional merit enabled the Committee to give assistance under Clause B of the Trust Deed. The average payment per beneficiary was £21, as against £15 in previous years, and three hundred students benefited. The Committee notes with regret a severe decline in repayments by former beneficiaries, only £1,160 having been repaid as against £5,379 in the peak year of 1946–47.

* Carnegie Trust for the Universities of Scotland. Forty-ninth Annual Report (for the Year 1949–50), submitted by the Executive Committee to Trustees on February 26, 1951. Pp. iv+70. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1951.)

CHEMISTRY AT THE UNIVERSITY OF SYDNEY

GIFT FOR NEW BUILDING

AN anonymous donor has recently presented to the University of Sydney a sum of £100,000. This, according to the official announcement by the vice-chancellor, Prof. S. H. Roberts, has been "given and accepted on the sole condition that it is to be used for the building of the first wing of a new Chemistry School, and in the hope that it will stimulate other donors".

Chemistry in the University of Sydney has a history going back a century, beginning with the arrival in 1852 of the Hon. John Smith—previously assistant professor of chemistry in Marischal College, Aberdeen—as "Professor of Chemistry and Experimental Physic". About 1874 a separate chair of chemistry was instituted, with Archibald Liversidge as its first occupant. Following him have been C. E. Fawsitt (1907–46) and R. J. W. Le Fèvre (1946–). From 1913 there has also been a chair of pure and applied organic chemistry, all four holders of which—Sir Robert Robinson, John Read, James Kenner, J. C. Earl—are now living in Great Britain.

Of the laboratories set up by Smith no signs remain. Those now in use are grouped around a nucleus laid out in 1889 by Liversidge. At intervals, various temporary and permanent additions have been made, so that in 1951 chemistry has available some 100,000 sq. ft. of floor space. This is not at all conveniently or efficiently arranged. In the University of Sydney a large number of students take chemistry

in the earlier years of their degree courses, and a particularly heavy commitment is what, in Great Britain, would correspond to Intermediate B.Sc. classes. For example, during the 1947 session laboratory facilities for some 2,100 such students had to be provided. Although by now (1951) this number has become approximately 1,100, it is not expected to become smaller in the foreseeable future.

Indeed, from 1953 onwards, it is anticipated that enrolments at Australian universities will rise by perhaps 1,000 per annum until about 1958, and thereafter by about 2,000 per annum until they reach a peak in 1965. These forecasts are based partly on the jump of the Australian birth-rate occurring in the late 1930's following the depression, and upon the growing flow of migrants to the Dominion. Furthermore, it is hoped that many South-East Asian students will in the future go to Australia for higher education or postgraduate work. It is intended, therefore, to utilize the present benefaction to proceed as soon as possible with the erection of a sufficient part of the eventual building to accommodate the large group of elementary students just mentioned, and thus enable them to leave the present factory-like, fibro-cement, temporary laboratory they now occupy.

Completion of a new Chemistry School must be necessarily dependent upon the provision of funds. It will be a development of benefit indirectly to a number of other departments of the University. These, at present working under extreme difficulties because of shortage of space and lack of modern facilities, will be able then to expand into much of the accommodation previously used by chemistry.

VOLUME TABLES FOR ESTIMATING TIMBER IN GREAT BRITAIN

FOR a century and a half at least on the Continent of Europe, for example, in Germany and France, volume tables have been in existence which enabled the forester and the timber merchant to calculate the volume of timber in crops of standing trees of various age classes, without having actually to measure the crops. These tables were based on a large number of measurements of selected areas of the same age, situation and soil, and so forth, carried out over a number of years and in blocks of forest which had passed through more than one rotation of careful management.

In tropical forest regions the first attempt to prepare volume tables was begun in India. The difficulty here was that the forests were virgin ones and not regular crops grown by man for at least one rotation, and allowances had to be calculated and allowed for. The user of the table therefore had to make certain allowances to the figures of volumes contained in the table. The Forestry Commission has been undertaking work of this description in Great Britain, and last year it published general volume tables for oak, beech, Scots pine and European larch* ; other tables are promised for birch, Corsican pine, Japanese larch, Norway spruce, Sitka spruce and Douglas fir.

The volume tables for broad-leaved species, including the one for beech, give average hoppus (or 'cubic foot quarter-girth') volumes over bark for trees of a given breast-height quarter-girth (abbreviated as B.H.Q.G.) and timber height. Breast height is taken at 4 ft. 3 in. above ground level (on the upper side of the tree on slopes) and volumes are measured, in lengths coinciding with 'stops', from ground-level to timber height, that is, an over-bark top diameter of 5–6 in. or to the point where the stem loses itself in the crown, whichever comes first. A 'stop' is a point on the stem at which there is a sudden change in diameter or a pronounced bend. No allowance is made for the stump, and branch wood of all dimensions is ignored.

The volume tables are intended to assist foresters, landowners and others in estimating the cubic contents of standing timber ; but, in order to achieve this purpose, their uses and limitations must be clearly understood. Trees with identical breast-height girths and heights may differ from one another in the rate of taper. The tables cannot therefore be relied upon to give accurate estimates of individual tree volumes ; they can only be expected to give satisfactory estimates for the aggregate volumes of a group of trees or of a whole stand. Even whole stands may differ from one another in stem form, although usually in a lesser degree, and it is therefore always advisable when first using a general volume table under a given set of conditions to test it on a number of felled stems grown under those conditions. If the table shows a definite bias, volume table estimates of standing timbers on that site will have to be adjusted accordingly.

Unless a stand is very small, it is usually not necessary to apply the volume table to every single tree. In old hardwood stands it is probably best to measure the breast-height quarter-girth and to estimate the timber height of every nth tree, the value of n being chosen so that there will be at least one hundred such trees ; for example, if there are five hundred, every fifth tree would be measured. The volume of the stand is then obtained by multiplying the total volume of the measured trees by n. In young hardwood stands and conifer stands of all ages, in which stem-length varies less erratically, it is usually best to girth all trees in order to determine the mean girth—that is, the girth corresponding to the mean basal area of the stand—and then to measure the heights of a number of trees near that mean girth in order to get a mean height. The volume for this mean girth and height, as derived from the volume table, multiplied by the number of stems, gives an estimate of the standing volume of the crop.

When estimating the volume of standing timber in large stands or whole forests, these or similar methods will usually be applied, not to the whole area but only to a representative sample of it. It requires a knowledge of sampling theory and of local conditions to find the most efficient sampling technique in any particular case ; but for many practical purposes and for working plan enumerations in particular, a ten per cent sample consisting either of parallel strips ½–1 chain wide or of small circular plots, spaced at regular intervals over the whole area, will often give efficient and unbiased estimates of adequate precision.

* Forestry Commission. Forest Record No. 5 : General Volume Table for Oak in Great Britain. By F. C. Hummel and W. T. Waters. Pp. 12. 4*d*. net. Forest Record No. 6 : General Volume Table for Beech in Great Britain. By F. C. Hummel and W. T. Waters. Pp. 12. 4*d*. net. Forest Record No. 8 : General Volume Tables for Scots Pine in Great Britain. By F. C. Hummel, T. W. Irvine and J. Jeffers. Pp. 28. 9*d*. net. Forest Record No. 9 : General Volume Tables for European Larch in Great Britain. By F. C. Hummel, T. W. Irvine and J. Jeffers. Pp. 26. 9*d*. net. (London : H.M. Stationery Office, 1950.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Oxygen Affinities of Respiratory Blood Pigments in *Serpula*

Serpula, a marine annelid worm, is the only animal known to possess two respiratory pigments in its blood, namely, chlorocruorin and hæmoglobin[1].

The hæmoglobins of mammals and of a variety of invertebrates have a considerably higher affinity for oxygen than the chlorocruorins of Serpulimorpha[1,2], a high affinity meaning that the pigment is oxygenated at a low pressure of oxygen. If, therefore, a mixture is made of an oxychlorocruorin and human oxyhæmoglobin, and then oxygen is progressively removed from the solution, a spectroscope shows that the α-band of oxychlorocruorin vanishes before the α-band of oxyhæmoglobin. But when the naturally mixed pigments in the blood of *Serpula* are gradually deoxygenated, the two α-bands disappear simultaneously. This means either that the hæmoglobin of *Serpula* has an unusually low affinity for oxygen, like that of the chlorocruorins hitherto examined, or that the chlorocruorin of *Serpula* has an abnormally high oxygen affinity.

This interesting point has remained unsettled since the time that the duplicity of the *Serpula* blood pigment was discovered, owing to the difficulty of finding big specimens of *Serpula*, which in most places is not an abundant serpulid. I have, however, now been fortunate in getting several moderately large live individuals of *S. vermicularis* L. from Plymouth. The worms were cut up in water and the liquid centrifuged, giving a solution with the brown colour characteristic of the blood of this genus. It is known that the relative quantities of the two blood pigments in *Serpula* vary with the age of the animal; in the solution which was prepared this time the two α-bands were equal in intensity. To a small optical glass tube containing about 0·5 ml. of the diluted *Serpula* blood, enough human blood was added to double (approximately) the intensity of the α-band of oxyhæmoglobin. Then a very small crystal of sodium dithionite was dropped in to remove most of the dissolved oxygen from the solution. The result was that, viewed with the microspectroscope, the α-band of oxychlorocruorin was seen to vanish, while the intensity of the α-band of oxyhæmoglobin was about halved. It is clear that only the human respiratory pigment remained in the oxygenated state; the hæmoglobin of *Serpula* was deoxygenated, together with the chlorocruorin. On aeration the bands reverted to their initial strengths. The experiment, which was repeated four times, showed that the chlorocruorin of *Serpula*, like other chlorocruorins, has a low oxygen affinity, and that likewise the hæmoglobin of *Serpula* has a low oxygen affinity. In this property the latter pigment differs from the hæmoglobins of other invertebrates[2] but resembles those of some fishes[3].

The hæmoglobin of *Serpula*, like all other hæmoglobins, contains protohæm. The chlorocruorins have their own peculiar hæm, chlorocruorohæm[4], and their proteins differ from globin of hæmoglobin[5]. It may well be that in the hæmoglobin of *Serpula*, protohæm is united to the protein of chlorocruorin and that this endows it with its low oxygen affinity.

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Density of Bottom Animals on the Ocean Floor

Our knowledge of the density (number and weight per sq. m.) of bottom animals in deeper waters is very scanty, since very few quantitative samples have hitherto been taken, and none at depths exceeding 1,000–1,400 m. It may therefore be of interest that the Danish Deep Sea Expedition in the *Galathea* has succeeded in taking thirteen quantitative samples with a 0·2 Petersen grab off the West African coast at depths between 820 m. and 3,782 m. The weight and number of species and specimens per sample are given in the accompanying table.

Locality	Depth (m.)	Weight of living animal per sample (gm.)	No. of species	No. of specimens
Off Takoradi	1,480	0·3	3	9
Off the Congo	2,680	0·1	1	1
" "	1,480	0·3	3	3
" "	820	0·9	4	6
" "	985	0·2	2	2
" "	1,150	0·2	1	1
" "	1,460	0·4	4	4
Off Angola (Lobito)	3,782	0·62	4	6
" "	2,430	0·42	2	2
" "	1,508	0·3	4	7
" "	1,200	0·6	6	17
" "	1,006	0·8	4	4
" "	985	0·5	4	8

Summarizing these results, it will be seen that the average weight of living animals in the six samples off the Congo from between 820 m. and 2,680 m. is 0·37 gm. per sample, that is, 1·85 gm. per sq. m. The number of species is on an average 2·5 per sample, that is, 12·5 per sq. m., and the number of specimens 3 per sample, that is, 15 per sq. m. These figures seem surprisingly high compared with those hitherto found at depths of about 1,000 m. in the Mediterranean, off Scotland and off Greenland. If the figures for the Angola coast are considered, the average weight per sample represents 0·5 gm., that is, 2·5 gm. per sq. m., with 3 species and 7 specimens per sample, that is, 15 and 35 respectively per sq. m., which seems to be a very high figure considering the fact that the depths are between 1,000 m. and 4,000 m.

There seems to be a difference between the deep sea off the Congo and off Angola, since the density of specimens appears to be distinctly higher off Angola. This is in good agreement with the fact that the productivity of the sea increases towards the south due to the influence of the Benguela Current and the upwelling water.

If we consider the results of the investigations with the Petersen grab in more shallow waters and

compare the tropical part of West Africa (off the Volta and off the Congo) with subtropical African waters (off Angola and off Walvis Bay) there is a very striking difference. Off the Volta and off the Congo the number of living animals per sq. m., even at small depths, 20–200 m., is very low, about 30–40 gm. per sq. m. at depths of about 10–20 m., falling to 1–10 gm. at greater depths. Off Lobito and the Cunene River the figures are somewhat higher, about 40–100 gm. at more shallow depths, 5–10 gm. at greater depths. Off Walvis Bay the figures are quite different, namely, 150–300 gm. living animals per sq. m. down to about 100 m., and thus resembling the order of magnitude in North European waters, while the density off the tropical parts of the African coast is much lower than that in the North Sea, in Iceland waters, etc.

Our experience from the first part of the Expedition is that there are no technical difficulties in taking quantitative samples with the 0·2 Petersen grab at depths of 4,000 m. and more, and it is now planned to carry through such sampling in the different deeps of the oceans as well as off the different coasts of the continents for the purpose of comparing the density of the fauna in the different parts of the oceans.

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Inhibition of the Biosynthesis of Tobacco Mosaic Virus by Thiouracil

SUBSTANCES capable of inhibiting specifically the formation of viruses are of obvious practical and theoretical interest. In the case of plant viruses, the composition of which are relatively simple and known, the opportunity exists of correlating the structure of an inhibitor with that of virus constituents and thereby gaining some insight into the problem of the biosynthesis of virus.

With this in view, we have investigated the effect of a series of substances on the rate of formation of tobacco mosaic virus in isolated tobacco leaf tissue. Of these, one, thiouracil, has proved to be a potent inhibitor at extremely low concentrations. The inhibitory effect is partially reversed by uracil, one of the pyrimidines which can be isolated from tobacco mosaic virus nucleic acid. The experimental procedure and results are briefly described here.

A healthy tobacco (*N. tabacum*, var. White Burley) leaf, 13 in. long, was detached from the plant and inoculated by rubbing with a solution containing 200 μgm. of purified tobacco mosaic virus per ml. The leaf was placed under a bell jar and maintained at 24° C. in 120 ft.-candles of fluorescent lamp illumination for 24 hr. Disks of blade tissue 12 mm. in diameter were then removed from the leaf, washed in sterile distilled water and floated on one-half strength Vickery's solution containing various concentrations of thiouracil in Petri dishes. These were maintained under sterile conditions at the above temperature and light intensity. Periodically, four disks were removed and analysed for tobacco mosaic virus by the method already described[1]. As we have previously shown, leaf tissue maintained in the absence of thiouracil under these conditions is capable of synthesizing amounts of tobacco mosaic virus comparable with those found in intact inoculated plants.

The effect of thiouracil on the amount of tobacco mosaic virus formed 220 hr. after inoculation is shown in Table 1. Complete inhibition of synthesis of tobacco mosaic virus is attained at a concentration of $4{\cdot}3 \times 10^{-5}$ *M* thiouracil. In all concentrations of thiouracil, the tissues remained turgid and epidermal cells exhibited protoplasmic streaming for as long as 300 hr. after inoculation. Hence, the effect of thiouracil on the formation of tobacco mosaic virus cannot be ascribed to death of the tissue. A series of experiments comparable to that described in Table 1 has been carried out with the same result.

Table 1. EFFECT OF URACIL AND THIOURACIL ON THE BIOSYNTHESIS OF TOBACCO MOSAIC VIRUS IN TOBACCO LEAF TISSUE

Leaf	Uracil ($M \times 10^{-5}$)	Thiouracil ($M \times 10^{-5}$)	Time of analysis : hours after inoculation	Virus present (μgm./100 mgm. tissue wet weight)
A	0	0	220	289
A	0	0·9	220	227
A	0	1·7	220	75
A	0	4·3	220	10
A	0	6·9	220	13
A	0	8·6	220	13
B	0	0	212	262
B	0·9	4·1	212	20
B	4·7	4·1	212	59
B	9·3	4·1	212	186

That the inhibitory effect of thiouracil is partially reversed in the presence of uracil is also shown by Table 1. These are results of an experiment similar in detail to that described above, except that disks were floated in nutrient containing the concentrations of uracil and thiouracil stated.

In a separate experiment similar to those cited above, the infectivity of homogenates (10 ml. of phosphate buffer, *p*H 7·0, per 100 mgm. of tissue) of inoculated leaf tissue cultured in nutrient medium containing various concentrations of thiouracil was determined by the half-leaf method using *N. glutinosa*. As shown in Table 2, the inhibition of virus formation caused by thiouracil is apparent from the reduced infectivity of tissue cultured in the presence of this substance.

Table 2. INFECTIVITY OF HOMOGENATES OF VIRUS-INOCULATED TISSUE CULTURED FOR 312 hr. IN VARIOUS CONCENTRATIONS OF THIOURACIL

Thiouracil conc. ($M \times 10^{-5}$)	Local lesions formed : Average No./half-leaf	Per cent of control half-leaf
0	12	19
2·0	12	22
4·0	6	14
7·0	4	9
10·0	1	3

Note. *N. glutinosa* half-leaves were rubbed with phosphate-buffer (*p*H 7·0) homogenates containing 10 mgm. of tissue per ml. Control halves were rubbed with solution containing 40 mgm. of virus per ml. Lesion counts are averages for 8 half-leaves.

These results suggest the possibility that thiouracil blocks synthesis of tobacco mosaic virus by interfering with some aspect of uracil metabolism which is normally essential for formation of the virus. This effect may be due to interference with the incorporation of uracil into the virus particle, or to an inhibition of a process more remotely related to the biosynthesis of the virus. The possibility also exists that virus-inoculated leaves may accumulate some precursor of tobacco mosaic virus under the influence of inhibitory concentrations of thiouracil. These aspects of the problem are now under investigation.

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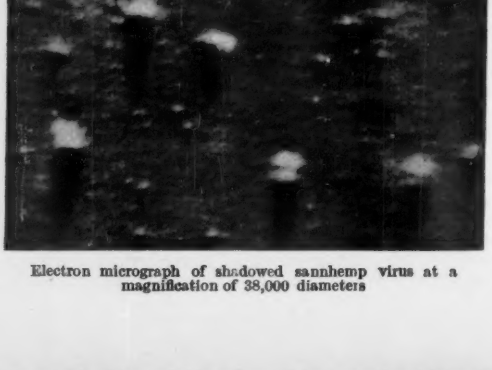
Structure of Sannhemp (*Crotalaria juncea* Linn.) Mosaic Virus with the Electron Microscope

A mosaic virus of sannhemp (*Crotalaria juncea* Linn.) was crystallized[1] at the Indian Agricultural Research Institute following the method suggested by Bawden[2]. Later, the virus was crystallized, employing the method of Markham and Smith[3] used for isolation and crystallization of turnip yellow mosaic virus. Control experiments conducted with the expressed sap of the leaves of healthy sannhemp plants and subjected to treatment similar to that given to the infective sap showed that no such crystalline substance could be obtained from healthy material. Solutions of the crystalline preparation indicated positive results in every inoculation test, and typical symptoms were produced on sannhemp plants. Raychaudhuri and Ramamoorty[4] studied the light-absorption curve of 0·11 per cent crystalline solution of sannhemp mosaic virus in a centimetre layer of the solution on a Hilger Spekker spectrophotometer *E*2, and observed two maxima, at 2770 A. and 2632 A., and a third one at 2958 A., with an inflexion point at about 2146 A. A preliminary study has now been made of the size and shape of the structures considered to be virus particles, as observed in the electron-micrographs of the crystalline preparation. The micrographs have been made with the electron microscope installed in the Institute of Nuclear Physics at Calcutta[5].

A micrograph of sannhemp mosaic virus shadowed with gold is reproduced herewith. A drop of the solution of crystalline virus in sterile water was dried on the collodion film mounted on the usual steel mesh. This was then shadowed with gold at angles ranging from $\tan^{-1}\frac{1}{5}$ to $\tan^{-1}\frac{1}{15}$. Several micrographs have been made of such shadowed specimens, and that reproduced is typical. This is a negative print; shadows are dark and the virus particles appear white. These electron micrographs seem to indicate that this virus consists of spherical particles. The measured diameter of the spherical particles varies from 40 to 26 mμ, the majority having a diameter close to 33 mμ. Further work is in progress.



Electron micrograph of shadowed sannhemp virus at a magnification of 38,000 diameters

The size and shape of different plant viruses crystallized so far are shown in the accompanying table for purposes of comparison.

Virus	Shape	Approximate size
Tobacco mosaic (ref. 6)	Rod	15 mμ × 300 mμ
Tomato bushy stunt (ref. 7)	Spherical	26 mμ
Tobacco necrosis (ref. 7)	,,	20 mμ
Southern bean mosaic (ref. 8)	,,	26 mμ
Squash mosaic (ref. 9)	,,	30 mμ
Turnip yellow mosaic (ref. 10)	,,	22 mμ
Sannhemp mosaic	,,	33 mμ

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Isolation of 17-Hydroxycorticosterone and 17-Hydroxy-11-dehydrocorticosterone from Hog Adrenals

The isolation of 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone from hog adrenals has been described by Kuizenga *et al.*[1,2]. The method described involved many stages and an extensive series of benzene–water partitions to effect the separation and isolation of these compounds, the fractionation being followed by means of biological assays.

In this communication we wish to report a simplified method for the preparation of concentrates of these compounds from hog adrenals, involving only four stages, and for the isolation of these compounds from such concentrates by a simple chromatographic technique, giving yields higher than those previously recorded. The following details describe a typical experiment.

33 kgm. of frozen hog adrenals was minced into 66 litres of 99 per cent acetone and extracted by stirring for several hours. After filtration, and re-extraction with 66 litres of 80 per cent v/v aqueous acetone, the acetone extracts were bulked and concentrated *in vacuo*, below 40° C., to remove most of the acetone. The aqueous concentrate was successively extracted with three half-volumes of petroleum ether (60–80°) to remove the fatty material and finally with three one-volumes of chloroform B.P. The chloroform, after drying over anhydrous sodium sulphate, was concentrated to dryness, *in vacuo*, giving 11 gm. of a thick oily extract.

35 gm. of purified wood pulp ('Solka-flok') was impregnated with propylene glycol by immersing the pulp in a 25 per cent v/v propylene glycol/chloroform mixture, filtering the pulp on a Buchner filter and allowing it to dry in the air to remove the chloroform. The pulp was then dry-packed into a chromatographic tube, 35 cm. long × 3 cm. diameter. The 11 gm. of concentrate was mixed with untreated wood pulp and the mixture packed on top of the column. Elution of the column was effected by means of toluene and 100-ml. fractions were taken. An aliquot of each fraction was taken after concentration *in vacuo* and run on paper strip chromatograms as described by Zaffaroni *et al.*[3]. An improved method of impregnating the paper strips with propylene glycol is to soak the strips in a 25 per cent v/v propylene glycol/chloroform mixture and then allow them to dry in air to remove the chloroform and give an even distribution of the propylene glycol on the strip. Control strips were prepared with 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone to act as markers and to permit an estimation to be made of the quantities of the compounds present. The bulk of the extract containing fatty material came through the column in the early fractions and contained no detectable amounts of 17-hydroxycorticosterone or 17-hydroxy-11-dehydrocorticosterone. The fractions containing these compounds were united and concentrated to dryness *in vacuo*. The concentrate was dissolved in a small volume of carbon tetrachloride and three volumes of petroleum ether (60–80°) added. The insoluble precipitate produced, weight 151 mgm., was found to contain substantially the whole of the 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone present in the original concentrate put on the column.

The crude material was redissolved in chloroform and the solution applied as a narrow band to two sheets of filter paper, 9 in. square previously impregnated with propylene glycol. The sheets were transferred to a chromatographic tank, using toluene as the mobile phase. The positions of the respective bands were determined by cutting out a narrow lengthwise strip of paper and spraying with ammoniacal silver nitrate solution or iodine solution. Strips corresponding to these bands were cut across the paper sheets and eluted with chloroform, the solution being washed with water to remove the glycol, dried to remove traces of water and finally concentrated *in vacuo*. 11 mgm. of 17-hydroxycorticosterone and 97 mgm. of 17-hydroxy-11-dehydrocorticosterone were obtained, their identity being proved by the usual means, including infra-red spectroscopy.

Attempts were made to convert other steroids present in the cortical extract, in particular, those in the fast-running fractions from the column described above, into 17-hydroxycorticosterone or 17-hydroxy-11-dehydrocorticosterone by incubating at 37° C. with preparations of adrenal tissue under a variety of conditions. No evidence of such biosynthesis was obtained. Our experience in this connexion leads us to support the view that only 17-hydroxy-11-desoxycorticosterone (Reichstein's *S*), which appears to be present in the cortex in minute quantities, is converted by adrenal enzymes into 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone.

This chromatographic method of isolation can be effectively applied to urine extracts. With urine extracts, however, two other unidentified bands reacting with the ammoniacal silver nitrate are obtained, one near the origin and the other in front of the 17-hydroxy-11-dehydrocorticosterone.

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Nature of the Factor in Soil-extract Responsible for Bacterial Growth-stimulation

Soil-extract is a valuable constituent of media for the growth of many soil bacteria. A medium containing only agar and aqueous soil-extract will give much higher plate counts from soil than any other medium in common use. Lochhead and Chase[1] showed that one-third of the bacterial cultures isolated from soil in soil-extract agar were unable to grow in a liquid medium containing a wide selection of amino-acids and vitamins, unless soil-extract was also added. They tentatively concluded that several different growth-promoting substances were involved. Some work on the nature of the soil-extract effect is briefly summarized here.

Dilution plates (1 : 500,000) were made from various soils in an agar medium containing soil-extract (25 per cent), peptone (0·05 per cent) and yeast-extract (0·05 per cent). Many of the cultures obtained from colonies on these plates would not grow initially in a casein–salts–vitamins medium, but a large proportion grew, either initially or eventually on subculture, in a medium containing 0·5 per cent peptone (Difco 'Tryptone') and 0·3 per cent yeast-extract (Difco). A number of cultures would not grow in this medium, or in several others tested, including that of Proom and Woiwod[2], but vigorous growth was obtained in the 'Tryptone' – yeast-extract medium if it were supplemented with aqueous soil-extract. Several of these cultures have been used as test organisms in the work now to be described.

Extracts of a number of Hertfordshire soils, prepared by autoclaving (15 lb./in.^{2} for 1 hr.) equal weights of soil and distilled water, were all active when added to the basal 'Tryptone' – yeast-extract

medium in 25 per cent concentration. Acetone or alcohol extracts were inactive. Extracts made with sodium hydroxide (0·1 or 0·01 *N*) were inactive; but extracts made by autoclaving or refluxing the soil with 0·3 per cent hydrochloric acid were highly active. Sulphuric acid extracts were usually inactive. Soil from untreated and farmyard manured plots in Broadbalk field, Rothamsted Experimental Station, were compared by the hydrochloric acid method of extraction; both soils gave active extracts, 0·5–1·0 per cent in the medium being sufficient to give good growth of all test organisms. Water or hydrochloric acid extracts of a number of acid heath soils were inactive.

Treatment of active extracts with cation-removing base-exchange materials ('Soucol', 'ZeoKarbs 215' and '216') removed activity; treatment with 'De-acidite' or charcoal had no effect. If sodium hydroxide were added, the solution heated and the resultant precipitate removed, all activity disappeared. If the extract were evaporated to dryness, the active material could be taken up from the residue by water but not by ether. Water extracts of the dry residue ashed by fusion or with concentrated sulphuric acid were inactive, but extracts of the residue after wet ashing with perchloric acid were active. On the basis of these results, a number of likely ash constituents were tested and it was found that calcium chloride would replace the soil-extract. If the calcium chloride were added to the basal medium before autoclaving, results were frequently unsatisfactory, but if sterilized separately and mixed with the sterile peptone – yeast extract medium, good growth was always obtained. Experiments with various test organisms indicated that minimal requirements of calcium chloride varied from 2·5 to 50 p.p.m. All soluble salts of calcium tested were effective. Strontium could replace calcium with all cultures; magnesium replaced calcium with some cultures. It seems likely that one or more of these cations are responsible for the effect of soil-extract.

The amount of calcium supplement required to allow growth in a 'Tryptone' – yeast-extract medium is related to the concentration of 'Tryptone' (see table). This suggests that the calcium may not be acting as a simple nutrient but may more probably be acting as an antagonist to some toxic substance present in the peptone. This view is supported by the discovery that different brands of peptone require different concentrations of supplementary calcium to promote growth.

The exacting organisms used in this work are Gram-negative; they appear to be plump rods when studied in heat-fixed films or chains of banded rods when stained in acid Giemsa. Growth is slow but substantial on nutrient agar; if the agar is replaced by silica-gel, growth is negligible. No growth takes place in liquid media unless soil-extract or the cations mentioned above are added. Some cultures are pigmented.

Growth of three cultures after 12 days at 25° C. in media containing 0·3 per cent yeast-extract and varying concentrations of 'Tryptone' and calcium chloride (+++ = vigorous growth; ++ = moderate growth; + = slight growth; − = no growth)

Culture No.	'Tryptone' (per cent)	Concentration of calcium chloride (p.p.m.) 0	5	10	20	50	100
173	0·2	−	−	−	+++	+++	+++
	0·5	−	−	−	+++	+++	+++
	1·0	−	−	−	−	+++	+++
	2·0	−	−	−	−	−	−
352	0·2	−	−	−	+++	+++	+++
	0·5	−	−	−	+++	+++	+++
	1·0	−	−	−	−	+++	+++
	2·0	−	−	−	−	+	++
362	0·2	−	−	−	−	+++	+++
	0·5	−	−	−	−	−	+++
	1·0	−	−	−	−	−	−
	2·0	−	−	−	−	−	−

Permission to obtain samples of soil from Rothamsted Experimental Station is gratefully acknowledged; I am indebted to my colleague Dr. E. B. Vischer for advice and assistance in the chemical part of this investigation.

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Multiple Infection of Clover Plants by Strains of the Nodule Organism in the Field

The possibility of obtaining, under experimental conditions, a simultaneous association of a leguminous plant with different strains of the nodule organism has been investigated by previous workers, with somewhat varying results[1]. So far as I am aware, the only published observations of multiple infection of a given legume plant in the field by strains of the nodule organism of different nitrogen-fixing powers are those included in the recent paper by Purchase and Vincent[2] which refer to clover plants under Australian conditions. Prior to the publication of this paper, I had begun an investigation of this aspect in clover plants growing in the west of Scotland.

A detailed study has been made of the strains of the nodule organism associated with six plants of red clover taken from hill-farm land near Aberfoyle, Perthshire, ten isolations of the organism being made from each plant, from different nodules. The effectiveness of these isolations in nitrogen fixation was tested on plants of red clover grown in aseptic culture in test-tubes containing an agar rooting-medium free from added combined nitrogen. The detailed procedure was similar to that described by Bond and McGonagle[3], except that the effectiveness of the isolations was assessed by comparison with a standard effective strain, taking the dry weight attained by plants as the basis for assessment. Isolations producing plants having a dry weight of not less than seventy per cent of that of the standard plants were classed as effective, those producing plants of dry weight not exceeding twenty per cent of that of standard plants were classed as ineffective and the remainder were classed as intermediate.

After statistical treatment of the data there is clear indication that each of the plants examined had associated with it at least two strains of the nodule organism, usually an effective and an ineffective type. In three plants there were possibly three or four strains present, differing in their powers of nitrogen fixation. Further investigations are being made to determine whether this multiple infection is prevalent in legumes in the field. If this is confirmed, it will help to explain the observation (by Dr. G. Bond) that when isolations of the nodule organism are made from single nodules from each of a number of clover plants growing in a given area, although both effective and ineffective strains may be obtained, the plants yielding the latter show no very marked difference

in nitrogen status from those yielding effective strains. To some extent this can be explained by the fact that under field conditions the plant is not entirely dependent on the nodules for its nitrogen nutrition. In addition, as a result of multiple infection, in a particular area, the proportion of nodules produced by effective and ineffective strains may tend to be similar on all plants, resulting in fairly uniform vigour.

It may be of interest that some of the effectiveness tests were carried out during the winter months, the natural light then available being supplemented with artificial light from a battery of 'daylight' fluorescent tubes arranged as described by Low[4]. The intensity of the artificial light alone at plant-level (12 cm. below the fluorescent tubes) was approximately 300 ft. candles, the light being supplied for sixteen hours each day. Very satisfactory growth was obtained under these conditions, the dry weight attained by the plants being only slightly inferior to that of plants grown in summer.

I am indebted to Dr. G. Bond for his advice during the course of this investigation and to the Botany Department, University of Glasgow, for the use of the fluorescent lights.

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Myxobacteria Mistaken for Nitrifying Bacteria

THE nitrifying bacteria, like the sulphur micro-organisms, have been studied almost entirely from a physiological aspect. With the exception of *Nitrosomonas* and *Nitrobacter*, the descriptions of the various genera have been copied from those given by the original investigators[1]. This has led to the description of nitrifying genera with the morphological characters of Myxobacteria, with which the cultures were, apparently, contaminated.

Although enrichment cultures similar to those originally devised by Winogradsky have been used by subsequent workers, only *Nitrosomonas* and *Nitrobacter* species have been isolated. The remaining five genera now listed[2], with the exception of *Nitrosocystis*, seem never to have been observed again. In my opinion, fruiting bodies of *Sorangium* were mistaken for colonies of nitrifying bacteria, and were described in the three genera, *Nitrosocystis*, *Nitrosoglœa* and *Nitrocystis*.

The descriptions and photomicrographs by H. and S. Winogradsky show that these genera are almost identical with one another. All three form large aggregates composed of numerous cysts. In some of the species, the cysts appear to be surrounded by a small sheath; but in every case they are composed of numerous, tightly packed, spherical or oval resting cells. This appearance is identical with that observed in *Sorangium* species.

Similarly, Winogradsky's photomicrographs of stained preparations of the disintegrated cysts of these genera closely resemble the appearance in *Sorangium*. Each shows the peculiar bean-shaped or wedge-shaped, capsulated structures arranged in pairs or tetrads, when stained by classical methods. My own cytological observations on *Sorangium* show, however, that this appearance is due to the fact that the microcyst wall is not readily stained. The microcysts actually contain a central vesicular nucleus, and are spherical or slightly oval in shape. Comparison of the photomicrographs of living and stained preparations of *Nitrosoglœa*, for example[3], show that this is also the case in the 'nitrifying' genera. The young cysts, photographed *in situ*, show tightly packed, spherical cells, which are not seen in the stained preparations.

The difficulties involved in obtaining pure cultures of nitrifying bacteria are well known. Although the inorganic medium prevents the growth of many micro-organisms, those Myxobacteria which are predatory on other bacteria could appear in the enrichment cultures. Examination for contaminants by the standard technique of inoculation into meat infusion broth fails to demonstrate their presence.

Winogradsky seems to have been unfamiliar with this group of the Myxobacteriales, because they are not mentioned in his soil studies[1]. The myxobacterial swarm is often difficult to detect, although the coloured fruiting bodies are visible to the naked eye.

Imsenecki has also suggested that *Nitrosocystis* is a species of *Sorangium* and has demonstrated that these Myxobacteria are common contaminants on cultures of nitrifying bacteria[4].

Nitrosocystis has been regarded by some workers[5,6] as a hard-colony variant of *Nitrosomonas*. In one instance[5], there is no evidence that the cultures employed were pure, and in the other[6] the brief description of the hard colonies in no way resembles the original descriptions of *Nitrosocystis*.

It would seem, therefore, to be almost certain that three of the genera of nitrifying bacteria now listed are invalid. They were, in fact, Myxobacteria of the genus *Sorangium* which were contaminating the cultures of *Nitrosomonas*.

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Microbiological Oxidation of Ammonium and Thiocyanate Ions in Soil

AMMONIUM sulphate[1] and sodium thiocyanate[2], when perfused through chalked soils neutralized by calcium carbonate, are metabolized by the growth of specific groups of soil microflora on the soil crumb surface to nitrate and ammonium sulphate respectively.

Thiocyanate is a known inhibitor of bacterial growth and poison[3,4] and is frequently found in sewage wastes. It has been reported to be highly toxic to the nitrification micro-organisms[5]. This inhibitory influence on the growth of the nitrifying micro-organisms in soil has been confirmed using the Audus modification[6] of the original soil perfusion technique[7].

Thiocyanate at a high concentration of 0·01 *M* when perfused through an enriched nitrifying soil has been found, however, to have only a partially inhibitive influence on the oxidation of ammonium sulphate, inhibiting the oxidation of ammonium-nitrogen to nitrite-nitrogen by 24 per cent and nitrite-nitrogen to nitrate-nitrogen by 62 per cent (see table). This is of interest, as it has been reported[1] that other sulphur compounds, thiourea and methionine, are highly toxic to the nitrification process.

20 gm. soil 1–4 mm. + 0·5 gm. precipitated chalk perfused with 200 ml. solution	After two days perfusion		
	Nitrite-nitrogen (μgm./ml.)	Nitrate-nitrogen (μgm./ml.)	Total nitrogen (μgm./ml.)
(1) Control, *N*/140 ammon. sulphate	0	100	100
(2) Control + *M*/100 sod. thiocyanate	38	38	76

The thiocyanate, after being perfused through a partially enriched nitrifying soil for four to five days, is metabolized to ammonium sulphate by a specific group of thiocyanate-oxidizing micro-organisms which grow in the soil, and it is thus possible to have a soil enriched with the three specific groups of soil microflora, the thiocyanate-oxidizing bacteria and the two groups of nitrifiers oxidizing ammonium ions and nitrite ions respectively. Using such a soil, it is possible to study the interrelationships of the three groups with respect to the utilization of their specific metabolites. Such a study has been made and the results are shown graphically in Figs. 1 and 2. The graphs demonstrate the biological oxidation of ammonium cations and thiocyanate anions in soil enriched with two groups, the nitrifiers, and soil enriched with the three groups, the nitrifiers and the thiocyanate oxidizing micro-organisms.

Using enriched nitrifying soils, ammonium cations are rapidly oxidized to nitrate, very little nitrite formation being observed (Fig. 1*a*), while thiocyanate (Fig. 1*b*), when perfused through a similar soil, is not metabolized until after a lag phase, when growth of its specific oxidizing micro-organisms takes place and the build-up of nitrite is observed, due to the oxidation by the nitrifying organisms already present in the soil of the ammonium cations formed.

When both groups are present (Fig. 2), ammonium cations are immediately metabolized to nitrite and to a lesser extent to nitrate. With the rapid growth

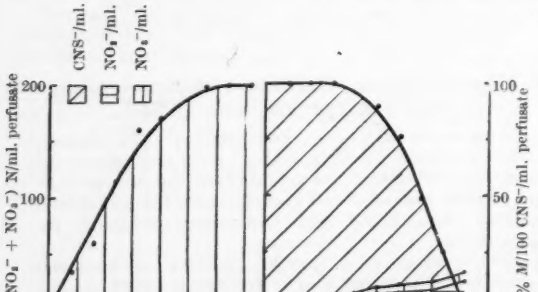

Fig. 1. 20 gm. soil (sieved, 1–4 mm.) + 0·5 gm. precipitated chalk. Enriched with nitrifying micro-organisms by previous perfusion with 200 ml. *N*/70 ammonium sulphate. Washed with distilled water and re-perfused with 200 ml. of (*a*) *N*/70 ammonium sulphate, and (*b*) *M*/100 sodium thiocyanate

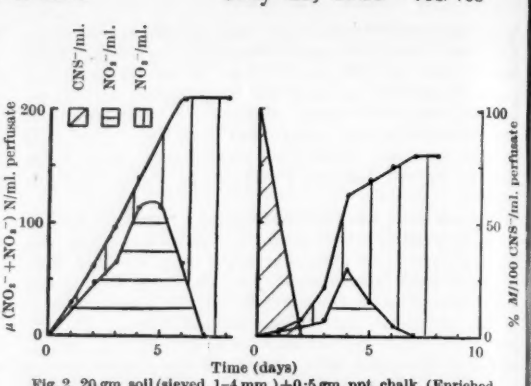

Fig. 2. 20 gm. soil (sieved, 1–4 mm.) + 0·5 gm. ppt. chalk. (Enriched with nitrifying and thiocyanate oxidizing micro-organisms by previous perfusion with 200 ml. *N*/70 ammonium sulphate and later perfusion with 200 ml. *M*/100 thiocyanate.) Washed with distilled water and re-perfused with 200 ml. of (*a*) *N*/70 ammonium sulphate and (*b*) *M*/100 sodium thiocyanate

of nitrate-forming micro-organisms, however, both ammonium cations and nitrite anions are rapidly metabolized to nitrate anions (Fig. 2*a*). Thiocyanate, when perfused (Fig. 2*b*), is immediately metabolized at a constant rate to ammonium sulphate, which in turn is metabolized via nitrite to nitrate as in Fig. 2*a*. These latter two oxidations are slightly inhibited until the thiocyanate is completely oxidized.

Thus, the inhibitive effect of thiocyanate on nitrification in soil is not permanent, and it is more toxic to the nitrate forming organisms than to the nitrite-forming group. The exact nature of its action is unknown. The experiments emphasize the usefulness of the soil perfusion technique in the study of dynamic biochemical processes occurring in the soil, and in the study of interrelationships of specific groups of micro-organisms as they occur in Nature.

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A Pronounced Sex Difference in Recombination Values in the Sixth Chromosome of the House Mouse

The loci *be* (belted), *Ca* (Caracul), and *N* (naked) constituting the sixth linkage group in *Mus musculus* are closely linked and in the order *be—Ca—N*. Linkage of *Ca* and *N* was established by Cooper[1]. He obtained the recombination values 2·64 per cent in males and 0 per cent in females, the difference not being significant on the total number of mice bred (335). Murray and Snell[2] discovered the factor *be* and established the order *be—Ca—N*. On combining their own data with those of Cooper, they obtained a significant sex difference (probability 0·043) for the segment *Ca—N*, there being 12 recombinants out of 392 mice bred from backcrossed heterozygous males,

while no recombinants were found among 158 mice bred from heterozygous females. For the segment *be—Ca* they obtained the recombination value 11·49 per cent, with no significant difference between the sexes.

In 1947 the genes *be* and *Ca* were introduced into stocks existing in this Department by means of mice sent by Dr. Snell from the Jackson Laboratory, and were combined with *N* in various associations. In 1949 I set up three-point backcross matings in order to redetermine the linkages simultaneously in the two segments and to investigate further the sex differences in the recombination frequencies. The experiment is still in progress, but the data so far accumulated exhibit a marked excess of recombination in the males over the *be—Ca* segment, and confirm the earlier indications in the *Ca—N* segment.

The backcrosses are of four types, *A*, *B*, *C* and *D*, in which the homozygous parents are *be++/be++*, and the heterozygous parents are respectively:

(*A*) *+Ca N/be++* (*B*) *be Ca N/+++*
(*C*) *be+N/+Ca+* (*D*) *++N/be Ca+*.

All types (except *A*, where male matings have not yet been set up) comprise matings both of female heterozygotes and male heterozygotes. It is proposed to achieve balancing between males and females as the experiment proceeds. The recombinant offspring of each type of mating fall into three classes, (1), (2) and (1,2), corresponding respectively to recombination in *be—Ca* only, to recombination in *Ca—N* only, and to simultaneous recombination in both segments. Table 1 shows the numbers in each class observed out of a total of 1,053 mice bred to date.

Table 1

Mating type	Female parent heterozygous (1)	(2)	(1,2)	Bred	Male parent heterozygous (1)	(2)	(1,2)	Bred
A	1	1	0	27	—	—	—	—
B	0	2	0	80	26	6	0	204
C	3	0	1	32	18	4	0	133
D	10	2	0	256	29	8	0	321
Totals	14	5	1	395	73	18	0	658

The observed percentage recombination values for the three segments *be—Ca*, *Ca—N* and *be—N* are thus as given in Table 2.

Table 2

	be—Ca	*Ca—N*	*be—N*
In females	3·80	1·52	4·81 per cent
In males	11·09	2·74	13·83 per cent

A χ_1^2 test applied to the four-fold tables for *be—Ca* confirms that the marked difference between the sexes in recombination frequency over *be—Ca* is significant at a level more extreme than 0·001 ($\chi_1^2 = 17·2$).

On the number of mice bred, the difference for the short segment *Ca—N* is not yet significant ($\chi_1^2 = 1·64$). However, when the new data for this segment are combined with those of Cooper and those of Murray and Snell, significance is achieved with a χ_1^2 equal to 5·18.

It is interesting to contrast the present situation in which two adjacent segments show the same property—recombination more frequent in the male—with that obtaining in the *A—un—we—pa* region of the fifth chromosome. Table 3 shows the results of a four-point backcross experiment (still in progress in this Department), which Prof. R. A. Fisher and Dr. A. R. G. Owen have kindly made available to me.

Table 3

	A—un	*un—we*	*we—pa*	Bred
Recombination in females	4·44	7·29	4·05 per cent	2,502
In males	4·43	4·42	2·39 per cent	2,263

Here the adjoining segments *un—we* and *we—pa* show a sex difference which is in favour of the female, in contrast to the position in the sixth chromosome. Moreover, the adjoining segments *A—un* and *un—we* exhibit a notable discontinuity in behaviour. The sex difference is marked and significant in *un—we* but entirely absent in *A—un*.

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Effect of Ascorbic Acid on Skin Permeability in Adrenalectomized Rats

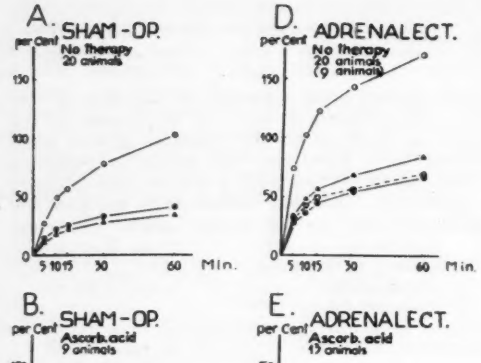
In recent years, facts have accumulated about the composition of the ground substance of the connective tissue proper. In loose connective tissue, this amorphous matrix consists of a highly viscous gel built up by acid mucopolysaccharides like hyaluronic acid and mucoitin sulphuric acid. The ground substance obviously is a very labile structure in respect of its physical and chemical composition. Among the agents that may have an influence on the composition of the interfibrillar gel, the adrenocortical hormones and ascorbic acid have attracted much attention.

With the aid of the spreading technique applied to dermal connective tissue of rabbits and mice, Opsahl *et al.*[1–3] have reported experimental results of a significant enhancing effect of adrenalectomy on the rate of spread of india ink in the skin of living animals. They were also able to show that adrenocortical extract restricted the spreading in intact animals. Animals exposed to a moderate stress likewise showed a restriction of dermal spreading, possibly due to a physiological effect of the adrenocortex hormone.

Several workers have ascribed an important role to ascorbic acid in the metabolism of the ground substance of connective tissues. Thus, restricted production of metachromatic substance in connective tissue of scorbutic animals is reported by various investigators[4,5]. So far as we know, no spreading tests have hitherto been performed for studying the effect of ascorbic acid in connexion with adrenal steroids.

In the course of investigations of hormonal effects on the ground substance of loose connective tissue, we have carried out experiments with a standardized spreading technique on adrenalectomized rats given deoxycorticosterone acetate and ascorbic acid as substitution therapy. Some preliminary results from these experiments are reported in this communication.

In our investigations the rate of dermal spreading of Evans blue and hæmoglobin was studied in the skin of living anæsthetized rats, and in skin flaps cut out from the same animals and injected supravitally. The results are shown in the accompanying diagrams. The pronounced increase of the spreading rate in the adrenalectomized rats is clearly shown in *D* when compared with the sham-operated controls (*A*). These results were obtained both in living skin and



Dermal spreading rate within one hour after injection of 0·10 ml. indicator solution (○●, Evans blue; △▲, hæmoglobin). The areas of the weals were calculated as regular ellipses.

—○—○— } weals in living skin *in situ*
—△—△—

—●—●— } weals in cut-out skin-flaps ('dead skin')
—▲—▲—

– – – ○ – – – ○ – – –, 9 animals tested 6 hr. after adrenalectomy. ACE = adrenocortical extract; DOCA = deoxycorticosterone acetate. Ordinates, percentage increase in weals; abscissæ, time after injection of indicators

'dead' skin six days after the operation. When, however, the spreading rate was measured within a short time after the operation (in this case six hours) no such effect of the operation was demonstrable in living skin (*D*, dotted line). This is presumably due to a stress effect of the anæsthesia and the operation, both of which may induce an output of adrenocorticotrophic hormone and thus of corticosteroids.

Ascorbic acid and deoxycorticosterone acetate, used in the clinic as substitutes for cortisone[6], were given together (*F*) in order to find out whether these substances had any effect on the spreading rate. The dosages used were 1 mgm. deoxycorticosterone acetate and 10 mgm. ascorbic acid per day administered intramuscularly. As a control, 10 mgm. ascorbic acid alone was administered both to sham-operated (*B*) and to adrenalectomized animals (*E*). Another group of intact, sham-operated animals was given 0·1 ml. adrenocortical extract per day (corresponding to 5 gm. cortex substance) intraperitoneally. The injections were started in immediate connexion with the operations, and continued with one injection every day until the spreading test on the sixth day after operation. This scheme was followed with all the groups except for the one tested six hours after adrenalectomy (*D*, dotted line).

The administration of ascorbic acid only (*E*) had a rather unexpected effect. The dose given seems to inhibit the 'barrier-breaking' effect of the adrenalectomy entirely. The animals given ascorbic acid thus showed the same rate of spreading as the sham-operated, untreated controls (*A*). Furthermore, this effect is valid for both living skin *in situ* and 'dead' skin flaps. Any important effect on the circulation can thus be ruled out. The combined treatment with deoxycorticosterone acetate and ascorbic acid has a rather small effect on 'dead' skin and none at all on living skin (*F*). In the sham-operated animals neither ascorbic acid (*B*) nor adrenocortical extract (*C*) showed any effect on the spreading.

The results given here do not offer any definite explanation of the peculiar effect of ascorbic acid on adrenalectomized rats. It is supposed by some workers[7] that the effect of adrenocortical hormones on the ground substance of connective tissue primarily concerns the activity of hyaluronidase present in the tissue. The ascorbic acid may act as an inhibitor of the hyaluronidase, which is possibly activated in animals deprived of their adrenals. Such an inhibiting effect of ascorbic acid can be demonstrated *in vitro*.

These investigations are being continued, and a detailed description will appear elsewhere.

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Antigens in the Developing Newt Embryo

Immune sera have been prepared in rabbits against isolated tissues of stages of embryonic *Triton alpestris*. The tissues used were: whole gastrula (crescent-shaped blastopore), archenteron roof, and ectoderm (both from early yolk-plug stages). The antisera were used both for interfacial precipitin tests and, diluted, as stock culture media of the same osmotic pressure as Holtfreter's solution; these media contained 1 : 5 to 1 : 20 parts of serum.

The experiments have involved the dissection of some six thousand embryos; but as most of the material has to be used for preparing immune sera or for absorption, the number of explants cultured is not as large as would be wished, and it seems best to sum the results from the two seasons 1949 and 1950; tests show that the figures of deaths and survivals for these years may be considered to come from the same sample.

A total of 579 explants were set up. The results in some of the classes are as follows. Of 104 explants into untreated antisera, 82 died within 48 hours (the

majority within 36); of 64 in normal serum, 12 died within the same period; of 29 gastrulæ in anti-gastrula serum, 19 died, and 4 showed defective development; of 24 in anti-gastrula serum absorbed with blastulæ, 17 died, 3 showed inhibited development; 1 in 21 and 1 in 7 died in, respectively, normal serum and normal serum plus blastula extract; of 28 morulæ in anti-gastrula serum, 25 died—2 as gastrulæ of inhibited development—the remaining 3 developed normally; and of 33 morulæ in anti-gastrula serum absorbed with blastula, 18 died, 11 showed inhibition of growth (2 of these survived for more than 48 hours), and 4 were unaffected.

Those classed as exhibiting inhibition of growth remained in general large-celled, with the blastopore forming a slight depression or small pit; in some cases, a dorsal lip was produced which bulged outwards, but there were no lateral lips. The dorsal lip did not appear to be invaginated for any distance.

These figures suggest the appearance of an antigen or antigens at or during gastrulation.

Turning to explants from the late gastrula: of 42 explants of archenteron or ectoderm into both anti-archenteron and anti-ectoderm antisera, 33 died; of 23 explants into control serum, 10 died; of 17 explants into homologous antiserum absorbed with heterologous tissue, 14 died; and of 17 explants into heterologous antiserum absorbed with homologous tissue, 8 died.

These figures suggest the possibility that archenteron and ectoderm contain one or more antigens in common, but also one or more specific to each.

This season it is hoped to continue the study of the origin of new antigens and their subsequent fates by testing these two antisera with antecedent tissues (blastula ectoderm) and subsequent derivatives (for example, neural plate and neurula ectoderm) after appropriate absorptions.

A full account will be published elsewhere.

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Estimation of Radioactive Hydrogen as Tritiobutane in the Geiger Counter

A method for the assay of tritium has been described by White, Campbell and Payne[1], who convert radioactive water into methane by means of aluminium carbide and then 'count' the methane in the proportional counter. Since this method necessitates additional proportional electronic equipment, I have found it more convenient to assay tritium in the form of radioactive butane, which can be 'counted' in the Geiger region and which, moreover, being condensable at liquid air temperature, is easily manipulated in a vacuum system.

Half the hydrogen of water can, of course, be incorporated into a selected hydrocarbon by reaction with the appropriate Grignard reagent. Butane was chosen in this case because Powell and Reid[2], in their work on the isomerization of butanes, actually prepared tritiobutane and reported it to be a good counter gas.

As carbon-14 is usually assayed in this Department by means of an internal beta-counter with graphite cathode and Neher–Harper quench circuit, this was the equipment first used for testing the properties of butane as a counter gas. At a pressure of 14 cm. mercury, some counters of this pattern show a well-defined Geiger region and a long, flat plateau; but as the proportion doing so is only about one in five, others, with passive iron cathodes, were tried. Of these a much higher proportion have a good characteristic provided the cathode is thoroughly outgassed; but some selection is still necessary. A good counter of this type (20th Century *GA*. 10*M*) containing *n*-butane at a pressure of 14 cm. mercury has a starting voltage of 3,000 volts and a plateau extending over 800 volts with negligible slope. External quenching appears to be essential.

At this pressure the counter contains about 12 standard millilitres of gas, which is the volume of butane theoretically obtainable from the action of 10 mgm. water on the Grignard reagent. As 10 mgm. is about the amount of water obtained from the combustion of convenient quantities of biological materials, a method for the conversion of water to butane on the 10 mgm. scale has been developed.

About 1·5 ml. of a freshly prepared 2*N* ethereal solution of *n*-butyl magnesium bromide is pipetted rapidly into a 10-ml. tube fitted with a *B*-10 standard socket. The tube is plugged on to a *B*-10 cone beneath a stopcock connected with the high-vacuum system, both joint and stopcock being lubricated with silicone grease. The total space beneath the stopcock is about 15 ml. The ether is removed from the Grignard reagent by distillation *in vacuo* with gentle warming. The whole tube is then baked out for two hours at 120°–130° on open pumps. This removes the last traces of ether which would otherwise dilute the butane formed at the next stage. A blank determination carried out by heating the reagent so prepared for an hour at 120° with the stopcock closed should yield no more than 150 μl. of gas.

The tube is allowed to cool and 10–20 mgm. of radioactive water condensed into it by means of liquid air. The tap is closed and the tube heated at 120°–130° for an hour. Tritiobutane is produced almost quantitatively (90–95 per cent of theoretical yield). It is purified by distilling through a *U*-tube cooled to − 78°. A suitable aliquot is measured out, condensed into the counter and the pressure adjusted to 14 cm. with inactive butane. Radioactive butane has not been found to contaminate the counter and a constant background counting-rate is observed between assays.

The method has been checked by assaying a stock solution of radioactive water (containing about 2 μC. per ml.) and various dilutions of it. The specific activity of the butane prepared from these various dilutions was, within experimental error, proportional to the dilution. This indicates that at these tritium concentrations no isotopic separation occurs during the reaction.

The accompanying table shows the results obtained when these samples of radioactive water were assayed. The calculated specific activity shown for each sample in column 5 is based upon the experimentally determined activity of the stock solution itself.

Water sample (% stock)	Vol. butane assayed (ml.)	Activity (c.p.m.)	Specific activity (c.p.m. per ml.) Obs.	Calc.	Error (per cent)
10	8·85	1,353	153	153	0
20	3·70	1,152	312	306	+2·0
40	2·59	1,554	600	612	−2·0
60	1·005 0·860	908 802	915	918	−0·33
80	0·805	972	1,210	1,224	−1·7
100	0·645	987	1,530	—	—

It would obviously be an advantage if a large excess of dry Grignard reagent could be prepared and then used several times. Unfortunately, it has been found that the butane produced by the action of a second sample of water on a once-used tube of reagent is contaminated by radioactivity from the first sample. This may be due to the fact that the yield is never quite quantitative. Furthermore, the yield on the second occasion is considerably reduced. However, using fresh reagent for each experiment, the method can be conveniently applied to routine tritium assays. The tubes of reagent are prepared in batches of six and baked out together on a manifold prior to use.

Thanks are due to the Calor Gas Company for supplying pure *n*-butane, and to 20th Century Electronics for their very helpful co-operation in designing and selecting counters.

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Solution of the Thomas–Fermi–Dirac Equation

The fundamental equation of the Thomas–Fermi–Dirac statistical atom model[1] is the so-called Thomas–Fermi–Dirac equation

$$\psi'' = x\left[\left(\frac{\psi}{x}\right)^{1/2} + \beta\right]^3, \qquad (1)$$

where ψ'' denotes the second derivative of ψ by x, β represents the constant $\beta = 3^{1/3}/(32^{1/2}\pi^{2/3}Z^{2/3})$ and Z the atomic number. This equation was solved by Umeda[2] for all neutral atoms with the boundary conditions derived by Brillouin[3]:

$$\psi(0) = 1, \quad \psi(x_0) = 0, \quad \psi'(x_0) = 0, \qquad (2)$$

where x_0 corresponds to the border of the atom. The second and the third boundary conditions are equivalent to the minimization of the energy of any single electron in the statistical atom. This requirement and the boundary conditions resulting from it are, however—as has been already mentioned by Jensen[4]—not in agreement with the statistical point of view, according to which the *total* energy of the statistical atom has to be a minimum, which is not equivalent to the minimization of the energy of the single electrons.

From the minimum-principle of the total energy of the neutral statistical atom, the following boundary conditions are obtained:

$$\psi(0) = 1, \ \psi(x_0) = \frac{\beta^2}{16}x_0, \ x_0\psi'(x_0) - \psi(x_0) = 0. \qquad (3)$$

It can be seen easily that the solutions obtained by these boundary conditions differ only at the outer parts of the atom from the solutions of Umeda, and even there only to a small extent. The solution of the Thomas–Fermi–Dirac equation with the boundary conditions (3) may therefore be determined from Umeda's solutions in the following way. The solution is put into the form:

$$\psi(x) = \psi_u(x) + k\varepsilon(x), \qquad (4)$$

where ψ_u denotes the solution of Umeda and $k\varepsilon$ is small compared to ψ_u. By k we denote a numerical factor independent of x. Putting this expression into (1) and expanding the right-hand side in terms of powers of $k\varepsilon$, one obtains for ε, by neglecting the terms of second and higher powers of $k\varepsilon$, the linear differential equation

$$\varepsilon'' = \frac{3}{2}\left[\left(\frac{\psi_u}{x}\right)^{1/4} + \beta\left(\frac{x}{\psi_u}\right)^{1/4}\right]^2\varepsilon. \qquad (5)$$

Singularities apart from $x = 0$ do not appear here, because the solution is of interest only between $x = 0$ and $x = x_0$, and the solution ψ_u disappears only at Umeda's x_0; this is larger than our x_0, which is determined here with the boundary conditions (3).

If one solves this equation with the boundary conditions

$$\varepsilon(0) = 0, \qquad \varepsilon'(0) = 1 \qquad (6)$$

the first of the boundary conditions (3) is fulfilled and also it follows that the constant k determines the initial slope of ψ, for it is:

$$\psi'(0) = \psi'_u(0) + k. \qquad (7)$$

The constants k and x_0 are determined from the second and the third boundary conditions (3). These calculations can be extended also to positive ions and spherical symmetrically compressed atoms.

The calculations are very simple and have been carried out by us for the atoms neon ($Z = 10$), argon ($Z = 18$), krypton ($Z = 36$), xenon ($Z = 54$) and radon ($Z = 86$), and for the single and double positive ions of these atoms. The tabulated solutions as well as the values of k and x_0 will soon be published in the *Acta Physica Hungarica*. By interpolation, solutions for further atoms can be obtained. The deviation of our solutions for argon, krypton and xenon from the exact solutions computed numerically by Jensen, Meyer-Gossler and Rohde[5] is less than 2 per cent.

We should like to express our thanks to Prof. Kwai Umeda for his kindness in having sent us his tabulated solutions.

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Decomposition of Formic Acid by Periodate

Since the introduction of periodic acid as a reagent for glycols[1], it has been widely employed for elucidating the constitution of many organic compounds[2]. In recent years valuable information has been obtained in the study of polysaccharides by oxidation with periodic acid[3]. Under suitable conditions, one molecule of formic acid is liberated from a non-reducing end-group, and two from a reducing end-group[4]. Determination of the formic acid set free may give an idea of the chain-length of a polysaccharide, while the consumption of periodate per repeating unit is useful in locating the position of hydroxyl groups therein. It is therefore necessary to

know whether or not formic acid itself is attacked by the reagent under experimental conditions.

While oxidizing hemicellulose from jute fibre (a methoxyuronic acid–xylan complex) with a saturated aqueous solution of potassium periodate (*p*H 4·1) at ordinary temperature, it has recently been observed that the amount of periodate consumed per gram of the hemicellulose is never constant, but increases with time. In order to see if the formic acid thus liberated is decomposed by periodate, 'Analar' formic acid of varying strengths was treated with periodate solution in the same way as hemicellulose, and the amount of periodate present in the reaction mixture was determined periodically by titration with sodium arsenite in presence of sodium bicarbonate[5].

Table 1. Amount of *N*/10 Sodium Arsenite (c.c.) Required for 10 c.c. of the Reaction Mixture (Potassium Periodate and Formic Acid)

Time (hr.)	Strength of formic acid in the reaction mixture			
	N/20	*N*/50	*N*/80	*N*/100
0	1·80	1·80	1·80	1·80
48	1·0	1·05	1·10	0·85
96	0·65	0·80	1·0	0·85
168	0·20	0·55	0·70	0·70
216	Nil	0·30	0·60	0·50
264	Nil	0·10	0·35	0·25

In more dilute solutions, formic acid appears to be unaffected by periodate (vide Table 2). It seems necessary, therefore, to maintain a strength of *N*/500 (or less) for formic acid in the final reaction mixture while using unbuffered periodate for oxidation.

Table 2. Amount of *N*/10 Sodium Arsenite (c.c.) Required for 10 c.c. of the Reaction Mixture (Potassium Periodate and Formic Acid)

Time (hr.)	Strength of formic acid in the reaction mixture			
	N/100	*N*/500	*N*/750	*N*/1,000
0	3·70	4·0	4·0	4·0
24	3·10	3·85	3·95	3·85
72	2·30	3·75	3·80	3·90
144	2·10	3·80	3·95	3·95

A practically constant value for the consumption of periodate per gram of the jute hemicellulose was obtained using the periodate in acid solution buffered at *p*H 3·09 with sodium acetate and hydrochloric acid.

In such a solution, formic acid of *N*/20–*N*/100 strength remains practically unaffected by periodate, as will be seen from Table 3.

Table 3. Amount of *N*/10 Sodium Arsenite (c.c.) Required for 10 c.c. of the Reaction Mixture (Potassium Periodate and Formic Acid) Buffered at *p*H 3·09

Time (hr.)	Strength of formic acid in reaction mixture			
	N/20	*N*/50	*N*/80	*N*/100
0	2·80	2·80	2·80	2·80
24	2·70	2·75	2·70	2·80
72	2·80	2·70	2·70	2·60
144	2·70	2·80	2·70	2·80
192	2·70	2·70	2·60	2·70
264	2·70	2·75	2·75	2·75

Iodine was set free whenever there was little or no periodate left in the system. It would appear, therefore, that potassium iodate is reduced by formic acid to iodide (which with iodate gives iodine in acid solution) in absence of periodate. This is supported by the fact that a saturated aqueous solution of potassium iodate at room temperature (31° C.) readily reacts with formic acid and sets free iodine; but in presence of potassium periodate it liberates no iodine. This is not apparently in agreement with the observation of Halsall, Hirst and Jones[6].

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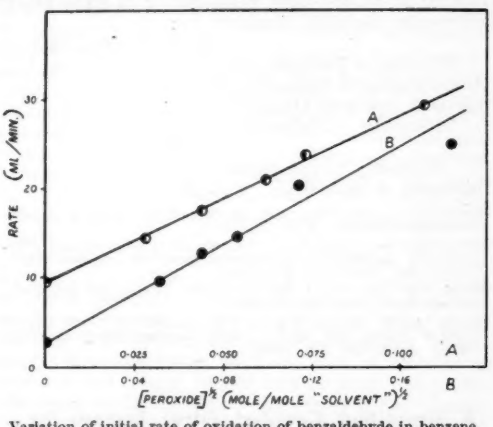
Mechanisms of Oxidation of Benzaldehyde

The early work of Bäckström[1] demonstrated the chain character of both the photochemical and the 'thermal', that is, dark, oxidation of benzaldehyde to peroxide in the liquid phase. We have studied the kinetics of the thermal reaction in benzene solution at 31° C., and have found it to be catalysed by di-benzoyl peroxide. The increase in rate $\Delta\rho$ above that of the uncatalysed reaction ρ_0 is proportional to the square root of the concentration of dibenzoyl peroxide, as shown in the accompanying graph.



Variation of initial rate of oxidation of benzaldehyde in benzene solution with concentration of dissolved di-benzoyl peroxide at 31·0° C. and 620 mm. mercury oxygen pressure.
1 mole 'solvent' refers to 1 mole (benzaldehyde + benzene), that is, ($N_{benzaldehyde} + N_{benzene}$) = 1.
Curve *A*, $N_{benzaldehyde} = 0{\cdot}224$; curve *B*, $N_{benzaldehyde} = 0{\cdot}132$.
Rates are expressed in ml. oxygen (25° C., 760 mm. mercury)/min. mole 'solvent'

With constant concentration of di-benzoyl peroxide, the dependence of $\Delta\rho$ on both oxygen and benzaldehyde concentrations is such as is required by the mechanism shown by Bolland and collaborators[2] to occur in the peroxide-catalysed oxidation of olefines, namely:

$$Bz_2O_2 \rightarrow R^-$$
$$R^- + O_2 \rightarrow RO_2^-$$
$$RO_2^- + RH \rightarrow RO_2H + R^-$$

$$RO_2^- + RO_2^- \rightarrow \left.\begin{matrix} \\ \\ \end{matrix}\right\} \text{Inactive products}$$
$$R^- + R^- \rightarrow$$
$$RO_2^- + R^- \rightarrow$$

where $RH = C_6H_5CHO$.

The evidence leaves little doubt that the peroxide-initiated oxidation of benzaldehyde occurs by such a free-radical mechanism, the chains being terminated by mutual interaction of two radicals.

It is also clear, however, that the reaction which takes place in the absence of added peroxide (and of light) does not occur by this mechanism. This follows from the fact that the total rate of reaction in presence of di-benzoyl peroxide is given by :

$$\rho = \rho_0 + \Delta\rho = \rho_0 + \varkappa[Bz_2O_2]^{1/2},$$

where ρ_0 is the rate of the peroxide-free reaction and $\varkappa$ is a constant for constant [*R*H] and [O_2] (see graph). If, on the other hand, the peroxide-free reaction occurred by the same mechanism as the peroxide-initiated reaction, the dependence of ρ on [Bz_2O_2] would be of the form

$$\rho = \varkappa'[\varphi + k[Bz_2O_2]\,]^{1/2},$$

φ being the (constant) rate of 'spontaneous' initiation, that is, of initial production of R^- or RO_2^- from benzaldehyde and oxygen, and k the specific rate of initiation by di-benzoyl peroxide. This is not the case. The peroxide-initiated reaction is therefore superimposed on the thermal reaction, which proceeds by a different chain mechanism.

In the presence of di-benzoyl peroxide, the oxidation of benzaldehyde thus takes place simultaneously by two distinct mechanisms. A similar result has been obtained by George[3] with tetralin containing di-benzoyl peroxide. It appears that, at least with benzaldehyde and tetralin, the occurrence of the free-radical mechanism set out above is dependent on the presence of decomposing peroxide, or of some other sufficiently energetic initiator[4].

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A Simplified Coupled Filter System for Adsorption Chromatography

Hagdahl[1] has described an improvement in adsorption technique of Tiselius and Claesson[2], whereby much clearer fronts are obtained by the use of small filters which are easily packed. These can be coupled together by means of short distance-pieces with narrow bore which act as front straighteners. The parts of the column are entirely of stainless steel, which combines the necessary degree of rigidity with resistance to attack from solvents. It has, however, been found that in the presence of certain adsorbent materials such as carbon, such steel is not completely resistant to solutions buffered at very low *p*H.

A more reliable container for the adsorbent can be made from 'Perspex'. The mechanical properties of this material, however, do not lend themselves to the construction of column components which require repeated screwing and unscrewing. A simplified model has therefore been designed which combines all the advantages of Hagdahl's original apparatus with much greater ease of production and assembly. The filters made from 1-in. diameter 'Perspex' rod are a sliding fit into an external jacket of stainless steel, and are held in position between a lower locking collar and the base of the solvent reservoir. For optimum performance the length of each filter is at least five times the diameter (Hagdahl[3]), and each filter in a set is constructed so as to be twice the volume of the one beneath it. The distance pieces are all $\frac{1}{2}$ in. in length, and are pierced by a 1/32-in. hole. The filters vary in size from 79·2 mm. × 15·9 mm. to 23·8 mm. × 4·76 mm. internal dimensions, giving volumes of approximately 5,000 mm.^{3} and 125 mm.^{3}. (These sizes are such that the necessary holes can be bored in a normally equipped workshop using standard British drills in 1/16-in. sizes.)

The overall length of each filter exceeds the internal by $\frac{1}{8}$ in. to allow for the insertion of a perforated disk to assist in the support of the adsorbent.

For carrier displacement adsorption chromatography[4], in which it is not necessary to make accurate and continuous observation of changes in refractive index of the eluate, a mixer as described by Hagdahl[1] is not required. In place of this a front straightener section terminating in a jet is placed at the bottom of the series of coupled filters for direct delivery into a fraction collector. After the individual filters have been filled under suction, they are introduced into the outer jacket starting with the jet, and adding distilled water after the addition of each subsequent section. The jackets are 1/16 in. shorter than the pile of filters and distance pieces, and when the upper end of the jacket is screwed into the base of the solvent reservoir, the filters are compressed into a completely fluid-tight column. Jackets of 14$\frac{1}{2}$ in., 11 in. and 8 in. length enable columns of 9,875, 4,875 and 1,875 πmm.^{3} volume to be assembled, thus affording adequate variation in size of column for most purposes.

Columns of this type have proved of considerable use in the quantitative separation of mixtures of small amounts of aromatic acids. A description of this work will be published elsewhere. I wish to thank both Mr. L. Hagdahl and Prof. A. Tiselius for most helpful advice and encouragement.

David A. Hall

Department of Medicine,
School of Medicine, Leeds.

[1] Hagdahl, L., *Acta Chem. Scand.*, **2**, 574 (1948).
[2] Tiselius, A., and Claesson, S., *Arkiv för Kemi, Min. Geol.*, (15B), **18**, 1 (1942).
[3] Hagdahl, L. (private communication).
[4] Tiselius, A., and Hagdahl, L., *Acta Chem. Scand.*, **4**, 394 (1950).

Adsorption of Water and Methanol on Coal

In a recent issue of *Nature*[1], an address by Sir Charles Ellis was summarized. From the data and theories of various authors, an attempt was made to depict the structure of coal. While we are in general agreement with these ideas, we have information that makes one feature of the theory seem doubtful. The concept that coal is a porous system of high surface area is a major feature of the theory. This idea is largely derived from measurements of heats of wetting in methanol and from adsorption isotherms of methanol and water on coal[2]. Although measurement of heats of wetting is probably not a very accurate method of determining surface area, the surface areas obtained approximate to those

obtained using adsorption isotherms of the vapours of the same liquid used in the heat of wetting measurement.

Results obtained in this laboratory (see table) indicate that the true surface area of coal is probably not measured by adsorption of methanol and water. These polar adsorbents are not physically adsorbed in the usual sense, and hence are not amenable to the usual Brunauer–Emmett–Teller treatment for derivation of surface area.

Coal	Surface areas* from isotherms of: Nitrogen −195° C. m.²/gm.	Water 25° C. m.²/gm.	Methanol 25° C. m.²/gm.
Lignite	3·5	290	307
High-volatile bituminous	1·5	94	115
Low-volatile bituminous	0·4	35	112
Sub-bituminous	1·6	310	408

* Computed from the simple Brunauer–Emmett–Teller equation, *J. Amer. Chem. Soc.*, **60**, 309 (1938), with the cross-sectional area of adsorbate molecules estimated in the usual manner.

It will be noted from the table that the surface areas measured by adsorption of nitrogen are quite small, scarcely more than could be accounted for by the external surface area. The surface areas measured by methanol and water are 50–200 times larger than the nitrogen Brunauer–Emmett–Teller areas and are in the range of values published by workers at the British Coal Utilization Research Association laboratories[2,3].

This type of behaviour is known for other materials. Studies of natural and synthetic polymers, particularly proteins and starch[4–6], have established that the adsorption of polar molecules does not give a measure of surface area but is probably related to the number of polar groups present in the adsorbent. However, the adsorption of argon or nitrogen gives surface areas of the same magnitude as those estimated from the average particle size[4,6,7]. These studies on synthetic and natural polymers suggest that water and other polar molecules actually penetrate the polymer and sorb on polar groups of the sorbent. Presumably, this phenomenon also occurs with coal. In addition, recent adsorption studies on carbon blacks indicate that the amount of adsorbed water[8–10], ammonia[8], or methanol[9,10] per unit area (as determined by nitrogen adsorption) increases as the oxygen content of the black per unit surface area.

These results will be published more fully elsewhere. In view of the information presented herein, we feel that a portion of the theory regarding the structure of coal should be modified.

J. A. Lecky
W. Keith Hall
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Bureau of Mines,
Bruceton, Pennsylvania.

Jan. 31.

[1] *Nature*, **165**, 583 (1950).
[2] Proceedings of a Conference on the Ultra-fine Structure of Coals and Cokes (British Coal Utilization Research Association, 1944).
[3] Bangham, Franklin, Hirst and Maggs, *Fuel*, **28**, 231 (1949).
[4] Benson and Ellis, *J. Amer. Chem. Soc.*, **70**, 3563 (1948); **72**, 2095 (1950).
[5] Shaw, *J. Chem. Phys.*, **12**, 391 (1944).
[6] Hellman and Melvin, *J. Amer. Chem. Soc.*, **72**, 5186 (1950).
[7] Zettlemoyer, Chand and Gamble, *J. Amer. Chem. Soc.*, **72**, 2752 (1950).
[8] Emmett and Anderson, *J. Amer. Chem. Soc.*, **67**, 1492 (1950); also unpublished data.
[9] Pierce and Smith, *J. Phys. and Coll. Chem.*, **54**, 354 (1950).
[10] Lecky (unpublished data).

Vegetative Propagation by Root Cuttings

Early in December 1949, we attempted the propagation by root cuttings of *Lagerstræmia indica*, previously submitted for a fortnight to the action of low temperatures (0°–2° C.) or to a dry atmosphere (relative humidity, 50 per cent) for one or two weeks. Immediately after each of these treatments, the cuttings were put in a rooting medium of equal proportions of sand and garden soil, in a greenhouse, together with controls. All the cuttings were planted upright, as recommended by the Kaiser-Wilhelm Institut.

Two months later, the first examination of the cuttings was made, and it was found that the percentage of best rooting occurred with cuttings previously submitted to dehydration for one week. Cuttings treated by other methods were much more weakly rooted, possibly because of harmful effects of excessive duration of the treatment.

The control cuttings developed better than either those submitted to two weeks of dehydration or those subjected to the action of low temperatures, but not so well as those submitted to one week of dehydration. This seems to us natural, since the tests were made during the season favourable for this type of cutting.

One month afterwards, that is, three months after the experiment started, another inspection showed that the best rooting again belonged to the group of cuttings subjected to one week of dehydration (82 per cent), that the other two treatments had a poor percentage of rooting (8 per cent for cuttings subjected to two weeks of dehydration and 0 per cent for those subjected to low temperature) and that the controls rooted normally (42 per cent), as was expected, because the season was favourable for the propagation by this type of cutting. The advantage of the seven days dehydration treatment was again remarkable as regards average number of roots and their average length.

Encouraged by these results, we carried out new attempts late in March, a season not commonly used for the propagation of this type of cutting. Cuttings of *Pyrus communis* sub-sp. *boreana* were used, together with *Lagerstræmia indica*, in these experiments. With the *Pyrus*, we found that, at the end of a month and a half, 70 per cent of those previously submitted to two weeks of dehydration had rooted, 48 per cent of those dehydrated for seven days, and no rooting at all of cuttings submitted to the low temperatures or of the controls. With the *Lagerstræmia*, we obtained the following results. At the end of a month and a half, 38 per cent in the group subjected to one week of dehydration had rooted, 12 per cent of those dehydrated for two weeks, and no rooting at all of the cuttings submitted to the low temperatures and 2 per cent of the controls.

From these observations, we can draw the following conclusions:

(1) Better rooting of root cuttings of these plants is obtained, due to interception of the polar transportation of auxins[1] by means of dehydration.

(2) Seven days treatment gives the best results in the conditions under which these experiments were carried out.

(3) When polar transportation of auxins is intercepted, the rooting process becomes independent of the season in which the cuttings are planted.

These conclusions offer an explanation of the observation that the best results with root cuttings are generally obtained in the open air and not in greenhouses.

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Lisbon.
Jan. 23.

[1] Marques de Almeida, Carlos Rebelo, "Acerca do transporte polar das auxinas" (1950).

Northward Distribution of *Gammarus pulex* (L.)

Since the discovery that *Gammarus lacustris* Sars occurred in the fresh waters of the mainland of Scotland[1], and that the form previously identified as *G. pulex* was most probably this species, there seems to have arisen a tendency to assume that the former species replaces the more familiar *G. pulex* in that area.

However, mutual exclusion by no means occurs and the two species overlap to a marked extent. *G. lacustris* ranges from the north of Caithness and Sutherland southward to at least the Highland Line. *G. pulex*, on the other hand, ranges north through the *G. lacustris* area and has been found in Inverness-shire at Rothiemurchus in water of *p*H 6·2 at Drumintoul spring. The water of this spring has an alkalinity of 2·7, reckoned as parts calcium carbonate/10^5 (estimates made by the late A. C. Gardiner). This is a somewhat unexpected environment for *G. pulex*.

Farther north and close to Inverness itself, *G. pulex* has been taken from the water-supply source of Leys Castle, where the *p*H is 6·6. This water flows into a small ornamental lake the sides of which have been concreted and the vegetation of which suggests that the water is alkaline. This lake also contains *G. pulex* abundantly.

The species has been taken from a small stream at Poolewe in the west of Ross-shire. In this stream no *Gammarus* could be found in 1943, when specimens identified as *G. lacustris* were introduced from a neighbouring loch; but the specimens taken from the stream (and now recorded as abundant) and sent to me for examination in 1945 were *G. pulex*.

Thus, so far as I know at the moment, the most northerly limit of the range of *G. pulex* in Scotland is a little south of the border of Sutherland. However, work is at present being carried out on the eastern side of that county, which has not apparently been investigated.

It will be seen from the foregoing that the factors which limit the northward range of *G. pulex* are not at all obvious, and it would not surprise me to find that this species occurs, albeit sparsely, in both the northern counties.

In assessing the distribution of these amphipods, one has to take cognizance of the fact that populations are apt to fluctuate enormously and suddenly, so that conclusions drawn as to the absence of a species after the most careful search may, in a year or two, be reversed by the appearance of abundant specimens. Lochs Poll a' Chnoic and Sgeirach near Stoer, W. Sutherland, both lost their population of *G. lacustris* in this sudden and inexplicable manner; in the case of the former, a population of many years standing disappeared between April and August 1947.

D. M. Reid

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Middlesex.

[1] Reid, D. M., *Ann. Mag. Nat. Hist.*, **6**, 11 (1940).

New Forms of *Spartina townsendii* (Groves)

Within the past few years there has appeared in the Dovey Estuary a number of plants of *Spartina townsendii* differing markedly from the usual form, and among these, two very distinct forms are especially noticeable. One is very dwarf (3–4 in. above ground) and with brownish leaves and sheaths and flowering only sparsely. The other is variegated and has a leaf-blade with usually a yellow median portion and a band of green tissue along either side; the flowering of this form is also sparse. As might be expected, the dwarf-brown form does not occur in the fully-meadowed spartinetum. It is fairly widely distributed as small plants and as patches of up to 6–8 ft. in diameter in the more recently colonized and semi-open areas towards the upper end of the estuary, and among the *Spartina* which is invading the grazed glycerietum.

The variegated form is restricted to a comparatively small area of 3–5 acres, and less than a dozen plants have been found, none being more than a few inches in diameter. It would appear, therefore, that this form is either of more recent origin than the dwarf-brown form or that it is incapable of persistence for more than two or three years.

It is curious that so far the variegated form, which is no smaller than a poorly grown specimen of the normal form, has not been found to occur elsewhere than within the limits of a patch of dwarf-brown, although no connexion between them has been found below ground. Consequently, its behaviour when free from competition has yet to be studied. It is now intended to investigate this point and other aspects of the ecological relationship between these forms, while their cytology will be investigated by Prof. P. T. Thomas.

The dwarf form has also been found by one of us in the Severn Estuary near Chepstow, and there again only in the recently colonized zones. Although about twice the height of the dwarf form in the Dovey, its relation to the normal form remains the same, since on the mud of the Severn site even the normal form grows to about twice the height achieved on the sands of the Dovey.

While some degree of variation has been recorded by other observers, particularly in regard to anthocyan pigmentation, such marked variation as is recorded here does not appear to have been described elsewhere, and the observations so far made suggest the possibility that these new forms represent the disintegration of the formerly stable hybrid polyploid.

E. H. Chater
H. Jones

Department of Botany,
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Aberystwyth.
March 10.

FORTHCOMING EVENTS

Monday, July 23—Wednesday, July 25

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at 47 Belgrave Square, London, S.W.1).—Summer Meeting.

Tuesday, July 24—Friday, July 27

BRITISH INSTITUTION OF RADIO ENGINEERS (at University College, Southampton).—Radio Conference, Sessions 3 and 4: Radio Communication and Broadcasting; Radio Aids to Navigation.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade B) IN CHEMISTRY at Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (July 28).

ASSISTANT (with a first-class honours degree in science or the equivalent) TO THE DIVISIONAL CHIEF SCIENTIST—The Divisional Establishments Officer, National Coal Board, Northern (N. and C.) Division, First Floor, Ellison Buildings, Ellison Place, Newcastle-upon-Tyne (July 28).

ASSISTANT LECTURERS IN ELECTRICAL ENGINEERING—The Registrars, The University, Manchester 13 (July 28).

HEAD OF THE ENGINEERING DEPARTMENT, Nigerian College of Arts, Science and Technology, Ibadan—The Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 15 Victoria Street, London, S.W.1 (July 28).

ASSISTANT IN MATHEMATICS—The Secretary, The University, Aberdeen (July 31).

DEMONSTRATOR IN ZOOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (July 31).

ENGINEER I at a Ministry of Supply establishment in Lancashire, to be responsible for the organization and technical administration of the inspection of electrical and allied equipment ordered by the Atomic Energy Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.288/51A (July 31).

EXPERIMENTAL OFFICER (Botanist) and EXPERIMENTAL OFFICERS (Zoologists or Chemists) for freshwater fisheries research at the Brown Trout Research Laboratory, Pitlochry, Perthshire—The Establishment Officer (Room 364), Scottish Home Department, St. Andrew's House, Edinburgh 1 (July 31).

PRINCIPAL OF THE MELBOURNE TECHNICAL COLLEGE—The Agent-General for Victoria, Victoria House, Melbourne Place, Strand, London, W.C.2 (July 31).

SCIENTIFIC OFFICERS in the Chief Scientist's Division, Ministry of Fuel and Power, London, for fundamental and applied research on problems affecting the production and utilization of fuel and power—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.466/51A (July 31).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER, and SCIENTIFIC OFFICERS (Zoologists), for marine fisheries research at the Marine Laboratory, Aberdeen—The Establishment Officer (Room 364), Scottish Home Department, St. Andrew's House, Edinburgh 1 (July 31).

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 1).

LECTURER IN ENGINEERING MATHEMATICS (including pure and applied mathematics and mathematical physics), and a LECTURER IN MEDICAL PHYSICS (to act also as Assistant Physicist to Aberdeen Royal Infirmary)—The Secretary, The University, Aberdeen (August 1).

CHEMISTS IN THE MATERIALS AND ANALYTICAL SECTION of a Ministry of Supply research and development establishment near London, (*a*) with experience of paints, varnishes and/or plastics, (*b*) with experience of paper and paper products and textiles—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.476/51A (August 4).

MECHANICAL ENGINEERS and NAVAL ARCHITECTS (Senior Experimental Officer grade) in Ministry of Supply headquarters, London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.387/51A (August 4).

PRINCIPAL RESEARCH OFFICER, WILDLIFE SURVEY SECTION of the Commonwealth Scientific and Industrial Research Organization, Canberra—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3404 (August 11).

ASSISTANT KEEPER (with a university degree in history or classics and a knowledge of either local history or general archæology) in the DEPARTMENT OF ARCHÆOLOGY AND LOCAL HISTORY—The Director, City Museum and Art Gallery, Birmingham 3 (August 13).

LECTURER or a SENIOR LECTURER IN VETERINARY HYGIENE—The Registrar, The University, Leeds 2 (August 13).

ASSISTANT LECTURER IN GEOGRAPHY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

CHAIR OF PHYSICS in University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Lecturer in Electrical Engineering' (August 15).

LECTURER IN MECHANICAL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (August 21).

PSYCHOLOGISTS, SENIOR PSYCHOLOGISTS, PRINCIPAL PSYCHOLOGISTS and SENIOR PRINCIPAL PSYCHOLOGISTS, in the Admiralty, War Office, Air Ministry and Prison Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 75/51 (August 23).

ELECTRONIC ENGINEERS in the Ministry of Supply, to work near London or at provincial stations on the development and design of electrically operated systems for a variety of applications, including weapons, telecommunications and radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.134/51A (August 24).

LECTURER IN VETERINARY HISTOLOGY—The Registrar, The University, Liverpool (August 31).

PHYSICIST, to work primarily on problems in agricultural meteorology—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (August 31).

RESEARCH ASSISTANT (with a good honours degree in chemistry, with physics, and some knowledge of a biological subject) to work on physico-chemical aspects of biochemical and immunological problems—The Secretary, Lister Institute, Chelsea Bridge Road, London, S.W.1 (August 31).

SENIOR LECTURER IN THE DEPARTMENT OF PHYSICS, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

CHAIR OF MINING—The Registrar, The University, Sheffield (October 6).

ASSISTANT DIRECTOR OF THE BOTANICAL GARDENS, Singapore—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/261.

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

CIVIL ENGINEERS (with a degree in Civil Engineering and/or corporate membership of the I.C.E.) in the Chief Engineer's Department of the Rhodesia Railways—The London Agent, Rhodesia Railways, 11 Old Jewry, London, E.C.2.

LECTURER IN TELECOMMUNICATIONS—The Head of the Electrical Department, Polish University College, 4 Egerton Gardens, London, S.W.3.

MECHANICAL ENGINEER in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Mechanical Engineer—4/8'.

PHYSICIST (previous experience in the medical or biological application of ionizing radiations is desirable), and a JUNIOR ZOOLOGIST (with an interest in experimental zoology and/or cytology)—The Director, Medical Research Council Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

PHYSICIST, to undertake research work and theoretical studies into problems associated with the design and operation of nuclear reactors, an ORGANIC CHEMIST, to take charge of a team engaged on organic chemical research, and an INORGANIC CHEMIST, to carry out research work on chemical and radiochemical problems associated with atomic energy development, in the Research and Development Branch, Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

PHYSICISTS or MATHEMATICAL PHYSICISTS: (Ref. A.133/51A/BB) PRINCIPAL SCIENTIFIC OFFICER with experience of radar systems analysis and war-time operational research (a strong mathematical bias is desirable); (Ref. A.134/51A/BB) SENIOR SCIENTIFIC OFFICER for theoretical investigations (a knowledge of statistical methods is desirable); AERONAUTICAL ENGINEER: (Ref. C.217/51A/BB) SENIOR SCIENTIFIC OFFICER with experience in planning and analysis of flight trials and application of results to project design (a knowledge of servo mechanism theory and practice is required); PHYSICISTS, MATHEMATICIANS OR ENGINEERS: (Ref. A.135/51A/BB) SENIOR SCIENTIFIC OFFICER with research experience involving arithmetical applications of mathematics in the analysis of physical data, and the formulation of problems for solution by automatic computing machinery (a knowledge of aerodynamics an advantage); (Ref. A.136/51A/BB) SENIOR SCIENTIFIC OFFICER with wide experience of methods of measurement in physics or engineering research, experience and up-to-date knowledge of electronics, at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

PRINCIPAL PHYSICIST to be responsible for the research work of a physics laboratory applying physical methods to the study of metals and to the development of methods of control of new metallurgical processes, and a PHYSICAL METALLURGIST to be responsible for the research work of laboratories engaged on metallographic, crystallographic and physical metallurgical investigations—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

RESEARCH ASSISTANT for isotope research (work will involve autoradiography, radioactive counting and maintenance of equipment, and animal experiments)—Mr. G. Rigby-Jones, Middlesex Hospital, London, W.1.

RESEARCH ASSISTANT for microbiological assays of vitamin B_{12}, folic acid and L. citrovorum factor—The Registrar, King's College, Newcastle-upon-Tyne.

RESEARCH MANAGER (with a first- or second-class honours degree in physics, or equivalent) at the Research and Development Branch, Windscale Works, Sellafield, to take charge of a group of laboratories engaged on applied research work covering a wide field in general and nuclear physics and biology—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting ARA/6.

RESEARCH OFFICER (with degree in physics, or equivalent) for work on problems in connexion with the use of fuel in domestic appliances, with particular reference to smoke elimination—The Assistant Secretary (Ref. A.23), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

SENIOR EXPERIMENTAL, EXPERIMENTAL, and ASSISTANT EXPERIMENTAL OFFICERS, to undertake and assist with experimental work involving a wide range of chemical and physical atomic energy development problems, and a SENIOR EXPERIMENTAL OFFICER to design and assemble special electronic equipment for research groups working on atomic energy development problems, at the Research and Development Branch (Applied Research), Windscale Works, Sellafield—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

SENIOR IRRIGATION ENGINEER, and an ASSISTANT IRRIGATION ENGINEER, in the Public Works Department, North Borneo—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/68.

WATER AND DRAINAGE ENGINEER in the Public Works Department, Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/217.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Registrar-General's Statistical Review of England and Wales for the Year 1949. (New Annual Series, No. 29.) Tables, Part 1, Medical. Pp. viii+380. (London: H.M. Stationery Office, 1951.) 7*s.* 6*d.* net. [304

Hannah Dairy Research Institute: a Brief Account of its Origin, Recent Extensions and Work. Pp. 40+4 plates. (Kirkhill, Ayr: Hannah Dairy Research Institute, 1951.) [304

A Kelvingrove Jubilee, 1901–1951. By William Power. Pp. 48. (Glasgow: Glasgow Art Gallery and Museums, 1951.) [304

Statement on the Results of the Post-War Five-Year Plan (1946–1950.) Pp. 20. (London: Soviet Weekly, 1951.) 1*d.* [25

Report of the Proceedings of the 1950 Conference of the Universities of Great Britain and Northern Ireland. Pp. 119. (London: Association of Universities of the British Commonwealth, 1951.) 1*s.* [25

United Kingdom Postgraduate Awards (Fellowships, Scholarships, Grants, etc.), 1951. Pp. 76. (London: Association of Universities of the British Commonwealth, 1951.) [25

Department of Scientific and Industrial Research: Building Research Station. National Building Studies, Special Report No. 11: Floor Finishes for Industrial Buildings. By G. E. Bessey. Pp. iv+28. (London: H.M. Stationery Office, 1951.) 1*s.* 6*d.* net. [25

British Standard 1121, Part 19: 1951, Methods for the Analysis of Iron and Steel, Part 19, Small Amounts of Soluble Silicon in Plain Carbon and Low Alloy Steels and Irons (Absorptiometric Method). Pp. 8. 1*s.* net. British Standard 1121, Part 20: 1951, Methods for the Analysis of Iron and Steel, Part 20, Tin in Highly Alloyed Steels (including High Speed Steels). Pp. 8. 1*s.* net. British Standard 1121, Part 21: 1951, Methods for the Analysis of Iron and Steel, Part 21, Aluminium Oxide in Permanent Magnet Alloys. Pp. 8. 1*s.* net. British Standard 1709: 1951, Nomenclature of Drawing Instruments. Pp. 9. 2*s.* net. British Standard 1710: 1951, Colour Identification of Pipe Lines. Pp. 13. 2*s.* 6*d.* net. (London: British Standards Institution, 1951.) [25

Library Association. Year Book 1951. Pp. lxv+513. (London: Library Association, 1951.) 15*s.*; 10*s.* 6*d.* to Members. [35

Memoirs of the Geological Survey of Great Britain: England and Wales. Geology of the District North and East of Leeds. By Wilfrid Edwards, Dr. G. H. Mitchell and T. H. Whitehead. Pp. vi+94+3 plates. (London: H.M. Stationery Office, 1950.) 7*s.* 6*d.* net. [35

The University of Glasgow through Five Centuries. Pp. 94. (Glasgow: The University, 1951.) 8*s.* 6*d.* [35

Town and Country Planning 1943–1951. Progress Report by the Minister of Local Government and Planning on the Work of the Ministry of Town and Country Planning. (Cmd. 8204.) Pp. vii+215. (London: H.M. Stationery Office, 1951.) 5*s.* net. [75

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